F-100 in Action

Century Series Portraits

Choppers On Carriers

PAGE 20

AIR&SPACE

Smithsonian

WHY THE HUSTLER WENT NOWHERE FAST

HIDDEN DANGERS ON A MARS MISSION

1915 LONDON VS. THE FIRST TERROR WEAPON

PAGE 50

JANUARY 2006

CONVAIR B-58 HUSTLER

World's Most Valuable Timepiece Disappears

Back in 1933, the single most important watch ever built was engineered for a quiet millionaire collector named Henry Graves. It took over three years and the most advanced horological technique to create the multifunction masterpiece. This one-of-a-kind watch was to become the most coveted piece in the collection of the Museum of Time near Chicago. Recently this ultra-rare innovation was auctioned off for the record price of $11,030,000 by Sotheby's to a secretive anonymous collector. Now the watch is locked away in a private vault in an unknown location. We believe that a classic like this should be available to true watch afficionados, so Stauer replicated the exact Graves design in the limited edition Graves '33.

The antique enameled face and Bruguet hands are true to the original. But the real beauty of this watch is on the inside. We replicated an extremely complicated early automatic movement with 27 jewels and seven hands. There are over 210 individual parts that are assembled entirely by hand and then tested for over 15 days on Swiss calibrators to insure accuracy. The watches are then reinspected in the United States upon their arrival.

What makes rare watches rare?

Business Week states it best…"It's the complications that can have the biggest impact on price." (*Business Week, July, 2003*). The four interior complications on our Graves™ watch display the month, day, date and the 24 hour clock graphically depicts the sun and the moon. The innovative engine for this timepiece is powered by the movement of the body as the automatic rotor winds the mainspring. It never needs batteries and never needs to be manually wound. The precision crafted gears are "lubricated" by 27 rubies that give the hands a smooth sweeping movement. And the watch is tough enough to stay water resistant to 5 atmospheres. The movement is covered by a 2-year warranty.

The face of the original 1930's Graves timepiece from the Museum of Time.

Not only have we emulated this stunning watch of the 1930s but just as surprising, we've been able to build this luxury timepiece for a spectacular price. Many fine 27-jewel automatics that are on the market today are usually priced well over $2,000 dollars, but you can enter the rarified world of fine watch collecting for under $100. You can now wear a millionaire's watch but still keep your millions in your vest pocket. Try the handsome Graves '33 timepiece risk free for 30 days. If you are not thrilled with the quality and design, send it back for a full refund of the purchase price.

Not Available in Stores

Call now to take advantage of this limited offer.

Stauer Graves™ '33 Wristwatch

Three Payments of $33 +S&H

800-859-1736

Promotional Code GRV198-04

Please mention this when you call.

To order by mail, please call for details.

Stauer

14101 Southcross Drive W., Dept. GRV198-04
Burnsville, Minnesota 55337

Visit us online at www.Stauer.com for the complete line of Stauer Watches, Jewelry and Collectibles

Respond before Dec. 31 to receive your coins in a PCGS Certified Gem BU holder at no extra charge!

Give the gift that endures... for seasons to come.

*** SILVER IS UP 70% IN THE LAST 3 YEARS!!**

*** GOLD IS UP 71% IN THE LAST 3 YEARS!!**

Coin images not to scale.

1 oz. $1 Silver Eagle — $9.20

Silver basis: $7.75

Since 1794, when the U.S. Government first struck Silver Dollars, they have symbolized monetary freedom and liberty. Today, the Silver American Eagles continue this historic tradition. No private collection is complete without the Year 2005 Silver American Eagles. The brand new, brilliant uncirculated Silver Eagles are minted from 1 oz. of 99.9% pure fine silver. At our amazingly low dealer cost price of only $9.20 per coin plus shipping, today is the perfect opportunity to add these true American treasures to your collection, before prices rise.

Limit ten (10) per household • Availability not guaranteed
New Customers Only • Prices subject to change

1/10 oz. $5 Gold Eagle — $52.00

Gold basis: $474

Savvy collectors regard the Gold American Eagles as the premier collectible gold coin in the world and the perfect way to maintain a private store of gold wealth. No private collection is complete without the Year 2005 Gold American Eagles. At our dealer cost of only $52 per coin plus shipping, now is the perfect time to add the brand-new, 1/10 oz. Year 2005 $5 Gold Eagles to your private collection. Guaranteed and backed by the U.S. Government, prices for these brilliant uncirculated, legal tender 22k gold treasures may never be this low again.

Limit three (3) per household • Availability not guaranteed
New Customers Only • Prices subject to change

1st Capital Reserve wants to be your rare coin team.
Call toll free today...800-877-3273

Vault Verification: CSMGS1205

1st Capital Reserve, L.P.
7135 Prutzman
Beaumont, TX 77706
(800) 877-3273

Silver/Gold price increase based from Jan. 2002 - Oct. 2005 • Texas residents add 8.25% sales tax to orders under $1000 • All customers will receive a five (5) year newsletter subscription ($200 value) at no charge with order • ***We may contact you from time to time regarding items of interest in the newsletter*** • If for any reason you are not 100% satisfied with your purchase, then return up to 10 days after receipt of order for a prompt refund • **Due to the changing price of silver and gold, ad price is subject to change • Please allow 2-3 weeks for delivery after receipt of good funds** • ***Silver basis: $7.75, Gold basis: $474***

24 Hours A Day • 7 Days A Week

OYSTER PERPETUAL COSMOGRAPH DAYTONA

WWW.ROLEX.COM ROLEX

NEW YORK

For fastest service, call toll-free 24 hours a day 800-859-1736

DECEMBER 2005/JANUARY 2006 VOL. 20 NO. 5

AIR&SPACE Smithsonian

FEATURES

Cover: *From 110 feet up, Chad Slattery got a lens-ful: Pima Air & Space Museum restorer John Heibler kneels to polish the broad, battered wing of the last B-58A Hustler Convair built.*

DEPARTMENTS

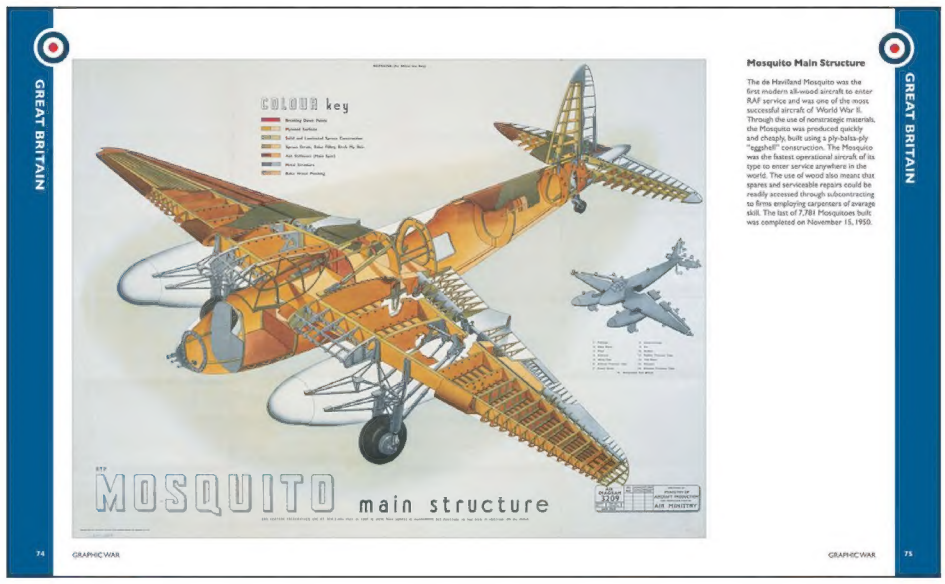
BY THE AUTHOR OF *"COCKPIT"* AND *"GUNNER"*

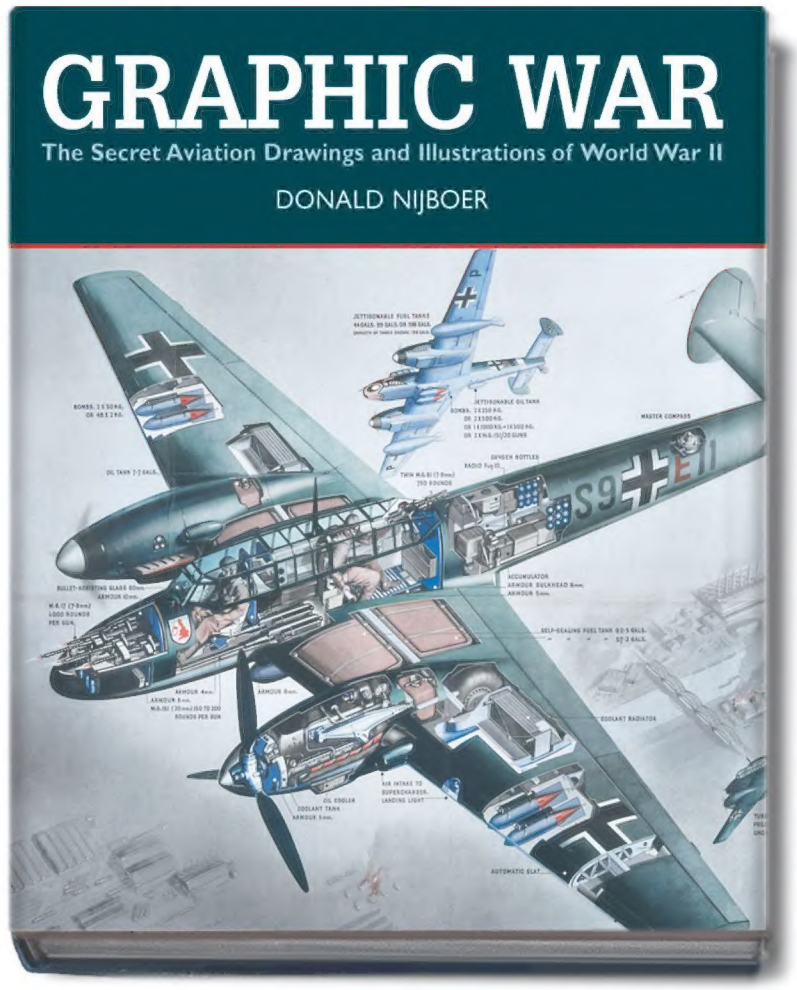
GRAPHIC WAR

The Secret Aviation Drawings and Illustrations of World War II

by Donald Nijboer

Originally classified as ***Restricted-Official Use Only***, these illustrations are from top secret training manuals and colorful instructors' posters. Packed with detailed cutaway drawings, they were intended to help young men win battles and save their lives.



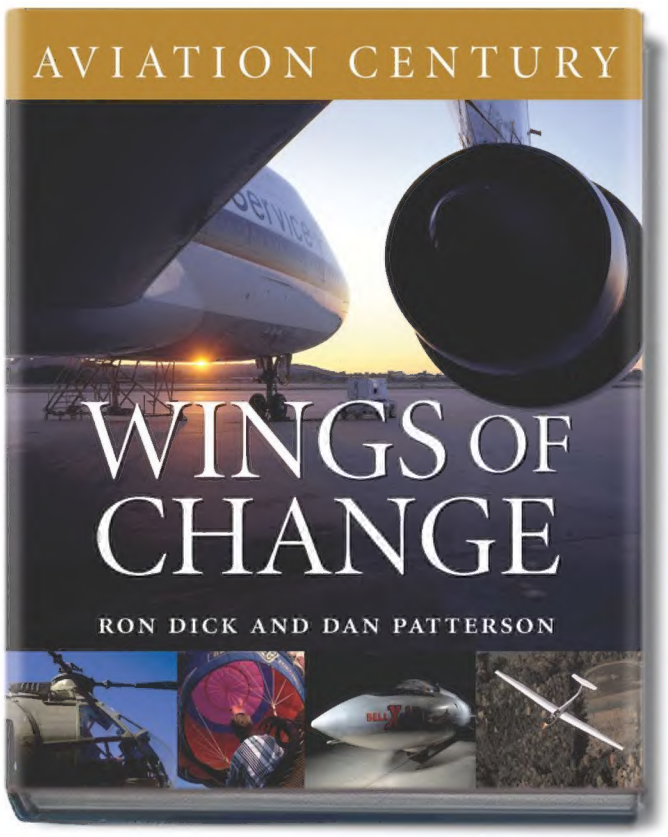


272 color pages • hardcover $49.95

Featuring almost 250 secret, vintage artworks, this fills an important gap in the war effort of America, Britain, Germany and the Soviet Union.

New in the *Aviation Century* series:

"Superb offering... a rare and remarkable accomplishment."
Walter J. Boyne, Aviation History



400 color and b&w images
288 pages • hardcover $39.95

WINGS OF CHANGE

by Ron Dick and Dan Patterson

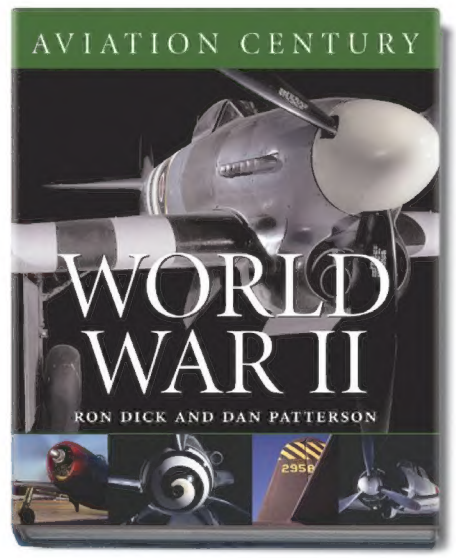
The dramatic story of how WWII bombers became the work horses of civil aviation.

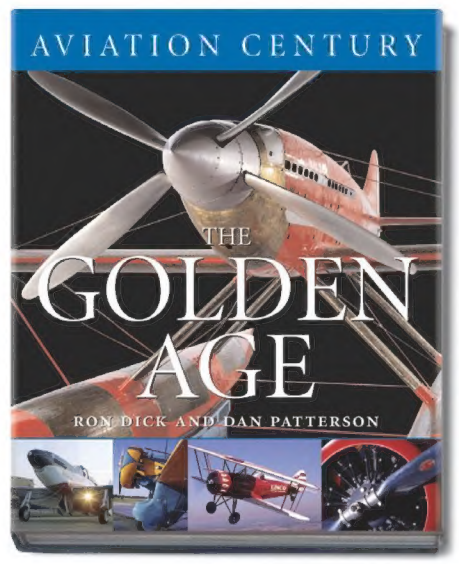
Distributed by

FIREFLY BOOKS
www.fireflybooks.com

Published by

The BOSTON MILLS PRESS





Truckin'

It's 5:50 a.m. at the Paul E. Garber Preservation, Restoration and Storage Facility in Suitland, Maryland. Load number 239, containing parts of a World War II Nakajima "Irving," a twin-engine Japanese night fighter, is given a final check before the Museum's tractor trailer, "Big Blue," departs the dimly lit storage buildings of Garber on its way to the brightly lighted floor of the Steven F. Udvar-Hazy Center at Dulles International Airport in Chantilly, Virginia. The 40-mile trip is often slow, even at such an early hour. At the Udvar-Hazy Center, another collections team is waiting with forklifts and dollies to take the artifacts off the trailer and position them on the enormous floor. By 9:00 a.m., the artifacts have been safely transported and the big semi is returning to Garber. All that before most people have their first cup of coffee.

Museum specialists who work in our collections division are responsible for the care and handling of artifacts and are entrusted with the safe transportion of every artifact that you see at the Udvar-Hazy Center. It has taken 25 months and nearly 250 trips to transport 200 large artifacts and over 1,800 small ones, and they're not finished yet. All told, that's approximately 20,000 miles—the equivalent of four round trips across the United States.

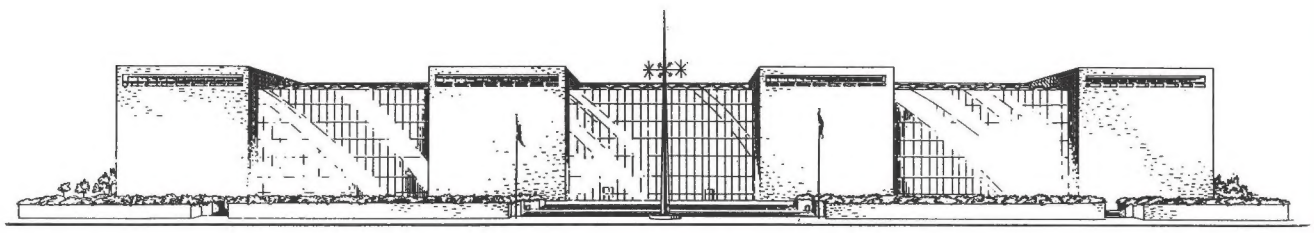
To accomplish this feat while supporting both our Museum on the Mall and an active loan program with other museums takes planning, coordination, communication, patience, and gut instinct. Each time an artifact gets loaded onto the tractor trailer, our people are exercising the utmost care and caution. Sometimes it can get tricky; after all, no two artifacts are alike. Fragile wood-and-fabric aircraft from the 1910s cannot be shipped in the same manner as an aluminum-and-composite solar probe spacecraft from the 1990s. And those are just two examples of the diversity of the artifact types we handle every day.

Larger objects like the "Irving" fighter must be disassembled before they can be shipped and can take several trips to move. In the case of this twin-engine fighter, even with its 55-foot-wide wings removed the airplane has a 20-foot-wide tail—the width of two lanes on the highway. So our experts had to remove half the tail, and the "Irving" ended up moving out to the Udvar-Hazy Center as four legal trailer loads. Of course, there are times when disassembly of an object is not possible or practical. When that happens, the resulting "superloads" travel at night with police and certified escorts protecting the artifacts' flanks from the flow of traffic around it.

There's nothing about this type of work that can be called typical; few people work at transporting rare objects every day. But we are in the business of preserving and participating in history, and so every day brings new challenges, physical and mental—which keeps our folks sharp and ready for anything.

The next time you see an air- or spacecraft on display at the Udvar-Hazy Center or our building on the Mall and wonder what it took to get it there, remember the dedicated men and women of the Museum's Collections Division.

—J.R. Dailey is the director of the National Air and Space Museum.



AIR&SPACE Smithsonian

Secretary of the Smithsonian Institution	Lawrence M. Small
Editor	George C. Larson
Executive Editor	Linda Musser Shiner
Senior Editor	Patricia Trenner
Senior Associate Editor	Perry Turner
Associate Editors	Bettina H. Chavanne Joe Pappalardo Diane Tedeschi
Consulting Editor	Tony Reichhardt
Photography/Illustration	Caroline Sheen
Researcher	Roger A. Mola
Graphic Design	Ted Lopez, Eason Associates, Inc.

Contributing Editors:

Roger Bilstein	W. David Lewis
William E. Burrows	Eric Long
Eric Chaisson	Stephen Maran
Tom Crouch	Laurence Marschall
David DeVorkin	Ted Maxwell
Ron Dick	Marshall Michel
Beth Dickey	Ron Miller
Freeman Dyson	Brian Nicklas
Daniel Ford	James Oberg
Greg Freiherr	Dominick Pisano
Donald Goldsmith	Robert E. Pollack
George Greenstein	Fred Reed
William Gregory	George Robinson
Dan Hagedorn	Chad Slattery
R. Cargill Hall	Marcia Smith
Richard Hallion	Robert W. Smith
Jim Hansen	Jill Tarter
Gregg Herken	Steven L. Thompson
Nick Komons	G.L. Verschuur
Nick Kotz	Stephan Wilkinson

Editorial: (202) 275-1230
e-mail: editors@si.edu
Web site: *www.airspacemag.com*

Air & Space/Smithsonian (ISSN 0886-2257) is published bimonthly by Smithsonian Business Ventures, MRC 951, P.O. Box 37012, Washington, DC 20013. Editorial offices: MRC 951, P.O. Box 37012, Washington, DC 20013. Circulation and advertising offices: 420 Lexington Ave., New York, NY 10170. Canadian publication agreement no. 40039324. Canadian return address: 7496 Bath Road, Unit 2, Mississauga, ON L4T 1L2.
Subscription Prices: U.S. and possessions: $24 a year payable in U.S. funds. Canada and all other countries: add $6.00 (U.S. funds) per year. Eighty-five percent of dues is designated for magazine subscription. Current issue price: $3.99 (U.S. funds). Back issue price: $7.00 (U.S. funds). Periodical postage paid at Washington, DC, and additional mailing offices.
Mailing Lists: We sometimes make our subscriber list available to companies that sell goods and services that we believe would interest our readers. If you do not want to receive such mailings, send your current mailing label or, an exact copy, to: *AIR & SPACE/Smithsonian*, Mail Preference Service, PO Box 420113, Palm Coast, FL 32142-0113.
Address Changes and Subscription Orders: mail to *AIR & SPACE/Smithsonian*, PO Box 420113, Palm Coast, FL 32142-0113; call 1 (800) 766-2149; outside the U.S., call 1 (386) 445-4662. (Postmaster: Send change of address to *AIR & SPACE/Smithsonian*, PO Box 420113, Palm Coast, FL 32142-0113.
Printed in the USA

The **fastest way to learn** a language. Guaranteed.™

Finally, a different approach that has millions of people talking. Using the award-winning Dynamic Immersion™ method, our interactive software teaches without translation, memorization or grammar drills. Combining thousands of real-life images and the voices of native speakers in a step-by-step immersion process, our programs successfully replicate the experience of learning your first language. Guaranteed to teach faster and easier than any other language product or your money back. No questions asked.

French **Italian** **German** **Japanese** **Thai** **Arabic** **Turkish** **Polish** **Swedish**
Chinese **Vietnamese** **Russian** **Indonesian** **Korean** **Hebrew** **Danish** **Welsh** **Pashto**
English **Spanish** **Farsi** **Portuguese** **Hindi** **Greek** **Swahili** **Dutch** **Latin**
(US or UK) **(Latin America or Spain)**

Award-winning software successfully used by U.S. State Department diplomats, Fortune 500® executives and millions of people worldwide.

Step-by-step immersion instruction in all key language skills:

Listening - Rosetta Stone uses native speakers and everyday language to develop your understanding of the spoken language naturally and easily.

Reading - Text exercises develop your reading skills by linking written language to real-life objects, actions and ideas.

Speaking - Speech-recognition feature records, diagrams and compares your voice to the native speaker's, grading your pronunciation.

Writing - Dictation exercises evaluate your spelling, syntax and punctuation.

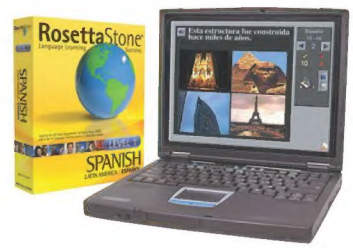
"...your program is the absolute best, bar none. I am shocked at how quickly I learn."

- Michael Murphy
Texas, USA

"Stupendous...the juxtaposition of text, sound and picture was masterful. The quality of both sound and graphics was first rate."

- The Boston Globe

Great Holiday Gift Idea



SAVE 10%

Level 1 Program	Level 2 Program	Level 1 & 2
Regularly ~~$195.00~~	Regularly ~~$225.00~~	Regularly ~~$329.00~~
		BEST VALUE!
Your Price **$175.50**	Your Price **$202.50**	Your Price **$296.10**

Personal Edition. Solutions for organizations also available.

Call today or buy online for a 10% discount.

RosettaStone.com/ais125

1-800-399-6174

Use promotional code ais125 when ordering.

Give the gift they'll talk about all year!

RosettaStone Language Learning Success

Unwrap the World.

AIR&SPACE Smithsonian

Smithsonian Institution

Publisher Thomas Ott
Associate Publisher Thomas M. Huber
Ad. Services Manager Marilyn Cruz

Advertising
Direct Response Mgr. Jim Smyth, (914) 693-8700
Daniel Walsh, (914) 693-8700
Southwest Carol Orr, (214) 521-6116
Midwest Dick Opfer, (312) 575-1100
Detroit Don Heth, (248) 642-7273
West Coast Gary Thompson, (310) 478-3833
Aerospace Pat Walker, (415) 387-7593
Canada (All Provinces) Richard Brown, (416) 259-9631
Florida Colleen Schoch, (561) 586-6671
Caribbean/Cent. Amer. Al Nadal, (305) 274-0803
Hawaii Audrey Higuchi, (808) 737-7422

Consumer Marketing
Vice President Scott I. Rockman
Circulation Director Lisa Dunham
Planning Director Elizabeth Hopkins
Fulfillment Director Andrea Sole
Memb. Services Coord. John O'Hare

Marketing & Research
Research Director Renee Mitchell
Research Manager Marilyn Resciniti

Production
Dir. of Manufacturing Sarah D. Kingsley
Production Director Greg Williams
Production Manager Katherine Balch
Digital Prepress Coord. Rachel L. Gilmore
Pre-Press Manager David Sterling
Asst. Pre-Press Mgr. Frank Matthew Hale II
Digital Color Analyst Rahsaan J. Jackson

Business Office
Executive Administrator Myrian Mora
Ad Systems Manager Michael Pollock

Smithsonian Business Ventures
Chief Executive Officer Gary M. Beer
Dir., Media and Corporate Development Jeanny Kim

LETTERS

The Luxury-Class Raptor

"The Raptor Arrives" (Oct./Nov. 2005) describes the F-22's mission as sanitizing the battlefield to allow "waves" of F-117s and B-2s to finish things off. Since there are only about 20 B-2s and 50 F-117s in the entire U.S. Air Force inventory, the author's definition of "wave" must be different from mine.

The F-22 is certainly a magnificent machine and perhaps the best fighter plane ever, but due to its cost, the Air Force may not be able to afford many other essential programs, and the rest of the force may suffer. By the time the Raptor is fully operational and it replaces the F-15, the F-117 and B-1 will be 30 years old, the B-2 will be 20, and the Air Force's youngest transport, the C-17, will be 25. No replacements for any of those planes are even on the drawing board.

For the cost of a four-plane formation of F-22s, you can buy a destroyer or 10,000 Hummers. One must wonder if the F-22 is a cost-effective weapons platform. It is literally worth more than its weight in gold, which is rather mind-boggling and a bit disgusting.

Chuck Goldsmith
Colorado Springs, Colorado

The Littler Engine That Could

"The Little Engine That Couldn't" (Oct./Nov. 2005) says: "Only 24 inches long, the [220-pound thrust] TRS 18 is still the smallest jet engine ever to power a manned aircraft." For almost two years now, I have been not only flying but also performing aerobatic routines at airshows in a Silent-J sailplane (based on the popular Alisport Silent-IN motor glider) powered by two AMT-USA AT-450 jet engines, which are only 11 inches long and weigh only five pounds! Originally designed for model airplanes, these engines produce 45 pounds of thrust, thus equalling the 9:1 thrust-to-weight ratio of the ill-fated Williams EJ22.

Photos and videos are on the Web site *www.silentwingsairshows.com*.

Bob Carlton
Albuquerque, New Mexico

It is misleading to state that the Garrett ATF3 and Rolls-Royce RB.211 engines are three-spool designs; they do not have the three-spool engine layout shown in Figure 2.

Both engines have three shafts, but only two shafts connect a turbine to a compressor. The third connects a turbine to a front fan, which blows air through a bypass duct, not through the combustion part of the engine.

Martin A. Snyder
Dublin, California

Editors' reply: The diagram is correct in its depiction of the mechanical architecture of a three-spool engine, but it deliberately avoids representing the design of any one specific engine, especially with respect to airflow. The RB.211 and the ATF3 differ radically from each other with respect to airflow.

Presenting the spools with no engine enclosure would have led to confusion.

The White Rocket's Storied Past

"White Rocket" (Aug./Sept. 2005) tries to dispel some myths about the T-38, including the "oft-repeated claim…that the T-38 climbs 33,000 feet a minute, even though the aircraft's time-to-climb record, set by Walt Daniel in 1962, is three minutes to 30,000 feet."

According to the Society of Experimental Test Pilots, which verified its information with the National Aeronautic Association, Daniels' record time to climb to 9,000 meters (for all jets of any size) was 64.758 seconds. Now, 9,000 meters is 29,528 feet, not 30,000. But it's hard to imagine that Daniel would have needed another one minute, 55.242 seconds to climb that last 472 feet.

Michael R. Pablo
Assistant, Contests & Records
National Aeronautic Association
Alexandria, Virginia

"White Rocket" brought back many memories. In 1954, I was responsible for predicting the characteristics of future aircraft engines for other Rand Corporation engineers, including Welko Gasich and T.V. Jones, to use in predicting future aircraft capabilities. My office was a couple of doors down from Welko's. One day he came in to chat and found me studying a newly arrived preliminary specification for the J85. Welko became excited when he looked at the J85 data, and he asked me for an estimate of how it would perform if it had an afterburner. He went back to his office and returned a couple of hours later, even more excited, and showed me a sketch of a small fighter he had conceived, based on two afterburning J85 engines. A few weeks after that, I was surprised to learn that Welko was leaving Rand to work for Edgar Schmued

Now With Enhanced Audio Performance And Styling.

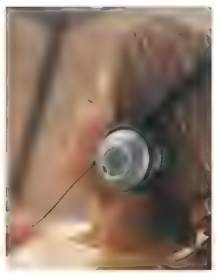
Think of them as a reprieve from the world around you. Whether it's the engine roar inside an airplane cabin, the bustle of the city or the distractions in the office, Bose QuietComfort® 2 headphones help them fade softly into the background with the flick of a switch. You can savor delicate musical nuances without disturbing others. And when you're not listening to music, you can slip into a tranquil haven – where you can relax and enjoy peace and solitude. Clearly, these are no ordinary headphones. It's no exaggeration to say they're one of those things you have to experience to believe.

"The QuietComfort 2 lives up to its name...It's easy to forget they're on your head." That's what columnist Rich Warren says. To enjoy peace and tranquility, simply turn them on. To add Bose quality sound, attach the included audio cord and connect them to a home stereo, laptop computer, portable CD/DVD/MP3 player or in-flight audio system. They also offer improved styling and a fold-flat design for easy storage in the slim carrying case.

Use them as a concert hall – or a sanctuary.

Presenting The Bose® QuietComfort® 2 Acoustic Noise Cancelling® Headphones.

Reduce noise with Bose technology. Our headphones were designed primarily for airplane travelers. But owners soon started telling us how much they enjoy using them in other places to reduce distractions around them. Bose QC™ 2 headphones incorporate patented technology that electronically identifies and dramatically reduces noise, while faithfully preserving the music, movie dialogue or tranquility you desire. *Technologyreview.com* reports, "It's as if someone behind your back reached out, found the volume control of the world, and turned it way, way, down." Perfect for listening to music, whether you're on the go, at home or in the office.



Enhanced audio from our best sounding headphones ever. When QC2 headphones were first introduced, *CNET* said, "All sorts of music – classical, rock, and jazz – sounded refined and natural." *Travel & Leisure Golf* said, "Forget 'concertlike' comparisons; you'll think you're onstage with the band." With their enhanced audio performance, today's QC2 headphones are even better, delivering audio that's so crisp and clear you may find yourself discovering new subtleties in your music.

Try the QC2 headphones for yourself, risk free. Our 30-day, in-home trial guarantees your satisfaction. If you aren't delighted, simply return your headphones for a full refund.

Call 1-800-417-2073, ext. Q4372 today. These headphones are available directly from Bose – the most respected name in sound. Order now and you'll receive a free portable Bose CD Player with skip protection – a $50 value. Plus, **shipping is free.** So call and discover a very different kind of headphone – Bose QuietComfort® 2 Acoustic Noise Cancelling headphones.

FREE Bose CD Player when you order by Jan. 31, 2006.

To order or for a free information kit, call:

1-800-417-2073, ext. Q4372

Discover all our innovative products at

www.bose.com/q4372

*Name*_____

*Address*_____

*City*_____ *State*_____ *Zip*_____

*Day Phone*_____ *Eve. Phone*_____

*E-mail (Optional)*_____

Mail to: Bose Corporation, Dept. DMG-Q4372, The Mountain, Framingham, MA 01701-9168

BOSE®
Better sound through research®

at Northrop on new aircraft designs. I was not surprised to learn what he was designing. A short time later I saw him at an airport, where he told me he was on his way to urge GE to put an afterburner on the J85 and make it man-rated.

Recalling these incidents, I feel that I was present at the very moment of conception of what became, after a lot of very clever engineering by Northrop, the T-38 and F-5.

Bruce Gist
Lynnfield, Massachusetts

No Immelmann for Us

We were puzzled when our B-47 crew was deployed to Andrews Air Force Base, outside Washington, D.C., but we soon learned the reason for the move ("A Full Retaliatory Response," Oct./Nov. 2005). When we practiced alerts, Air Force Chief of Staff Curtis LeMay and a few Congressmen came in a big black car to watch.

Jones portrays the B-47 bomb delivery tactic as zooming in to the target at low level, then tossing the bomb before executing a 180-degree Immelmann. He is referring to the infamous LABS (Low-Altitude Bomb System) maneuver. The delivery tactic we trained for and would have used was the pop-up. You approach the target at low level, pop up over the target, release the weapon, then dive for the deck straight ahead to get away as fast as possible.

Col. Dan Cassiday,
U.S. Air Force (ret.)
President, B-47 Stratojet Assn.

Sonic Booms: Rumblings of Dissent

So let me get this straight: According to the sidebar "Sonic Booms Cause Obesity" ("The Boom Stops Here," Oct./Nov. 2005), Edwards Air Force Base and the surrounding area have been host to tests of high-performance jet aircraft since the P-59 in World War II. Now the Air Force is trying to appease yahoos who move to the area, then have the audacity to complain about the noise.

Just typing that made my blood pressure go up.

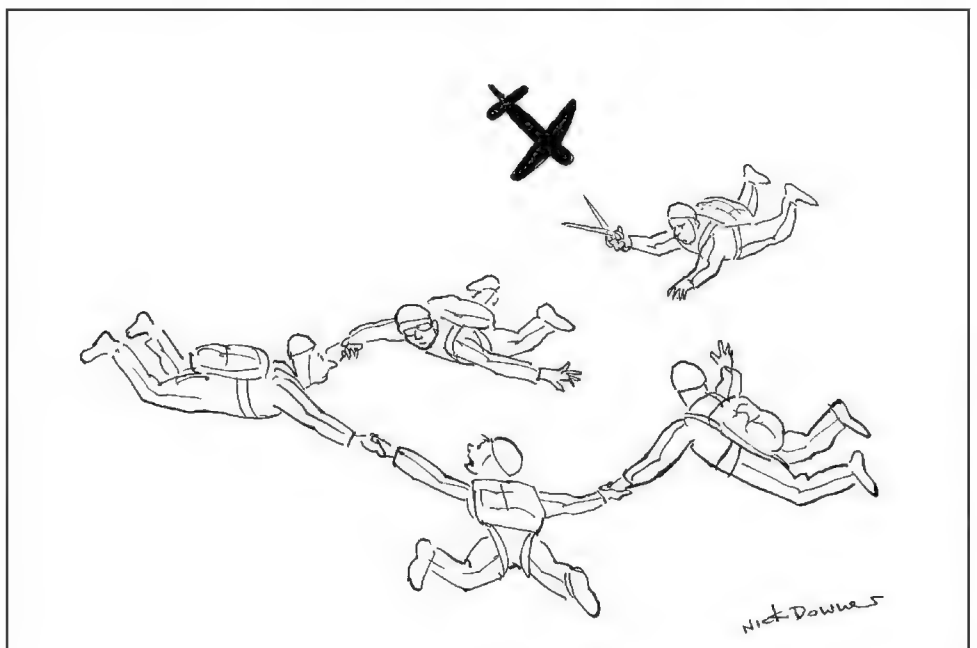
Tom Kipp
Reynoldsburg, Ohio

The picture of an F/A-18 with a condensation cloud around it has a caption attributing the cloud to the aircraft breaking the sound barrier. The speed of sound has nothing to do with the cloud forming. The cloud is caused by air expanding aft of the maximum cross-sectional area of the aircraft. Most of the flow ahead of that area is compressed and there is no condensation. A condensation cloud has also formed above the canopy, where the air is likewise expanding as it flows over the canopy.

The Navy also has lots of photos showing all types of aircraft flying in high humidity, with the condensation clouds incorrectly attributed to the aircraft breaking the speed of sound.

Ralph M. Barnes
via e-mail

Editors' reply: The caption correctly attributes the cloud to "air pressure changes, combined with just the right humidity levels." However, the F/A-18 was not breaking the sound barrier.



"I think my husband is getting suspicious."

Of Youthful Vintage

In "Vintage Charmers" (Feb./Mar. 2005), Chad Slattery errs when he reports that the Vintage Sailplane Association accepts "all sailplanes produced through 1958, plus modern replicas of those models."

Thanks in large part to the late Paul A. Schweizer, an internationally recognized icon to sailplane enthusiasts, VSA created a separate category, the Classic Sailplane Division, which accepts certain sailplanes that were designed and built *after* 1958 but are more than 25 years old. By recognizing the value of these "future vintage" classics, the VSA encourages the preservation of machines developed during the critical years between the late 1950s and the early 1990s, a period that revolutionized not only sailplanes but aviation in general. That period saw the introduction of composite materials, which enabled radically more efficient designs. As a result, within about 10 years, sailplane performance more than doubled, and the machines built in that period ushered in what many consider some of the most dramatic changes in aircraft design in the 20th century.

Jim Kellett
Chairman,
Classic Division
Vintage Sailplanes
of America

Corrections

Oct./Nov. 2005 Reviews & Previews: (1) The subtitle of the book *Chopper* should read: *A History of American Military Helicopter Operations From WWII to the War on Terror.* (2) In the same review, we regret misspelling Robert Kelley's surname.

"The Raptor Arrives": The photograph on p. 44 shows an F-15E, not an F-15C.

"A Full Retaliatory Response": We regret misreporting A. Craig Mizner's name as Craig A. Mizner.

"Best in Show" (Soundings): The Grumman Duck's designation is J2F-4, not J24-F.

Write to us at Letters, Air & Space/ Smithsonian, *MRC 951, P.O. Box 37012, Washington, DC 20013-7012. Please type or print clearly. You must include your full address and your daytime phone number.*

Note our new e-mail address: editors@si.edu. *You must include your full name, mailing address, and daytime phone number.*

Air & Space *is not responsible for the return of unsolicited materials. Never send unsolicited original photographs; send only copies.*

All letters selected for publication are edited. We regret that we cannot respond to every letter.

Brains Conquer Beauty

Scientists break code to create perfect gemstones with even more fire and brilliance than mined diamonds.

There is little doubt that a natural mined diamond of top quality is one of the world's most magnificent gems. It is much coveted for its exquisite beauty, but the simple truth is that diamonds are just compressed crystallized carbon. The laboratories at Diamond*Aura* were created with one mission in mind: *Design classic jewelry with scientifically perfect gemstones at a cost that lets everyone experience a stone with more fire and brilliance than a mined diamond.*

Perfection from the laboratory. We named our gemstones Diamond*Aura*, because simply said, "they dazzle just like natural diamonds but without the outrageous cost." Our Diamond*Auras* are an absolute marvel of modern gemological science. We insisted that our scientists reproduce the look of a natural mined diamond in the laboratory, and would not accept any result other than perfection. We will not bore you with the incredible details of the scientific process, but will only say that it involves the use of natural occurring minerals heated to an incredibly high temperature over 5000°F. This can only be accomplished inside some very modern and very expensive laboratory equipment. After several additional steps, our scientists have finally created a gemstone that looks even better than the vast majority of mined diamonds. Frankly, each time we see one, we have difficulty believing the result ourselves. Noted jewelry expert Steven Rozensky said, "The color and clarity of Diamond*Aura* rivals that of a flawless D colored diamond". Of course, flawless diamonds sell for in excess of $50,000 a carat, so they are priced out of reach. Only experienced diamond appraisers utilizing the proper instruments are able to make the distinction between a flawless natural diamond and a scientifically perfect Diamond*Aura*.

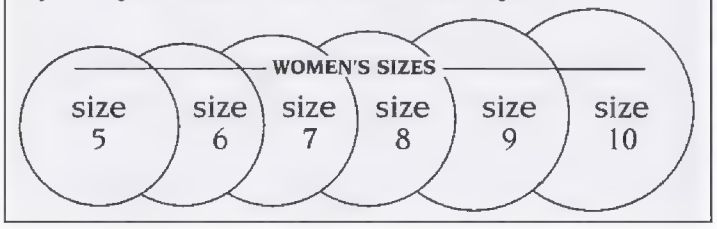
Color– Similar to a D Colored Diamond
Clarity– Rivals a Flawless Gem
Cut– the radiant "Brilliant Cut"
Carat Weight– Starting at 1.58 ctw and up

The 4 C's. Our Diamond*Aura* stones retain every jeweler specification: color, clarity, cut, and carat weight. All the essential components that comprise a top quality naturally mined diamond are present in an exquisite Diamond*Aura*. In purely scientific measurement terms, the refractory characteristics of Diamond*Aura* are ***actually superior*** to a diamond and both will cut glass. The color and the clarity of a Diamond*Aura* are laboratory reproduced to simulate the world's most perfect diamonds. The cut, of primary importance for any top quality gemstone, is artistically performed by our team of experienced gemstone cutters, and the carat weight is made available to you in the entire range of most desired sizes. Finally, we employ the most talented jewelry designers to provide our customers with the dazzling elegant styles that we proudly offer. Once you have had the opportunity to wear your Diamond*Aura*, you will understand why it is just like a natural diamond in almost every way.

Rock solid guarantee. Every Diamond*Aura* stone is mounted in platinum plated sterling silver. We believe this setting brings out the perfect color and clarity of the stones. Try the Diamond*Aura* gemstones risk-free for 30 days. If for any reason you are not satisfied with your Diamond*Aura* purchase or you experience any defects in the stones, please just return it to us for a full refund of the purchase price.

If you prefer something less perfect, you could buy a natural low quality diamond like many jewelry stores offer and still pay much more.

Place one of your own rings on top of one of the circles. Your ring size is the circle that matches the diameter of the inside of your ring. If your ring falls between sizes, order the next larger size.



Not Available in Stores

Call now to take advantage of this limited offer.

Diamond*Aura*

A. 3-Stone Ring (1.78 ctw) (whole sizes 5-10) **$99.95** +S&H
B. 3-Stone Necklace (1.58 ctw) **$99.95** +S&H
C. 3-Stone Earrings (3.16 ctw) **$99.95** +S&H
D. Tennis Bracelet (15.50 ctw) **$199.95** +S&H

800-937-4400

Promotional Code DAJ229-03

Please mention this when you call.
To order by mail, please call for details.

Stauer
14101 Southcross Drive W.,
Dept. DAJ229-03
Burnsville, Minnesota 55337
www.stauer.com

X-Rated Rocketplanes

ROCKET RACING LEAGUE

Like NASCAR, in 3-D, and louder: Space entrepreneur Peter Diamandis' new scheme calls for ultra-high-powered homebuilts on a 5,000-foot-high racing circuit.

Last October, just prior to the Countdown to the X-Prize Cup in Las Cruces, New Mexico, Peter Diamandis of X-Prize fame and partner Granger Whitelaw, an auto racing executive, announced the formation of the Rocket Racing League, a NASCAR-style race with rocket-powered aircraft that will debut in 2006.

"It's bringing 21st century racing into people's living rooms," Diamandis says. "It's really the mix of NASCAR excitement and spaceflight." Whitelaw takes a different but enthusiastic tack. "It's nothing like NASCAR or Indy car," he says. "It's 10 times louder."

"For me, it's sort of a remembrance of 'Star Wars' pod racing," Diamandis says.

XCOR Aerospace of Mojave, California, builds the EZ-Rocket, which will serve as a prototype for the vehicles, called X-Racers. The aircraft, a Rutan Long-EZ with a pair of isopropyl alcohol-fueled rockets in the engine compartment that can be stopped and started in flight, debuted at the Experimental Aircraft Association's annual bash at Oshkosh, Wisconsin, in 2002. Diamandis and Whitelaw plan on having four X-Racers ready for demonstration flights next year, and another six in production in time to fly at the October 2007 X-Prize Cup, an annual civil spaceflight exhibition planned for Las Cruces.

The Rocket Racing League is looking for corporations and sponsors to own and operate the X-Racers, each of which will cost less than $1 million to manufacture, and is soliciting proposals from cities that want to host rocketplane races. The X-Racers will launch vertically and fly along aerial tracks about two miles long, one mile wide, and 5,000 feet high. Satellite navigation systems will keep the vehicles on the correct track. Spectators and Internet participants will view the race on video screens that set the action on a three-dimensional track and include options for close-up camera views and technical information. The league also plans to license X-Racing home video games and merchandise, as well as sell television broadcasting rights.

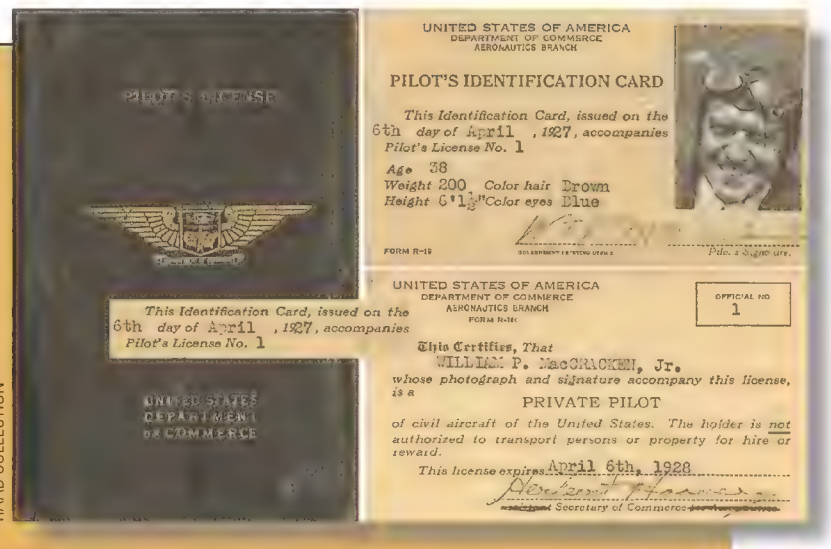
Beyond the thrill of watching airplanes with 20-foot-long exhaust plumes blast across the sky at 300 mph, Diamandis says there is a serious side to rocket racing: building demand and expertise for safe, highly efficient rockets, vehicles, and supporting technologies that will help open the space frontier to private enterprise.

"Over the last 40 years, I've grown tired of waiting for the government to do it," he says. Diamandis has been behind several private space initiatives, including Zero Gravity Corporation, which sells rides aboard an aircraft that simulates microgravity, and Space Adventures, which among other services brokers rides to space aboard Russian Soyuz rockets.

—Irene Klotz

FOR COLLECTORS

Making It Legal



RAAB COLLECTION

The Raab Collection, which deals in rare historic documents, letters, and manuscripts, offers for $38,000 the first pilot's license issued by the United States government. In May 1926, Congress passed the Air Commerce Act, which encouraged the development of aviation through regulation. The bill's author, William MacCracken, former Army pilot and founder of the National Aeronautic Association, was named Assistant Secretary for Commerce of Aeronautics, and on April 6, 1927, he was issued the nation's first pilot's license, signed by Secretary of Commerce Herbert Hoover. Perhaps foreseeing a need for the now ubiquitous photo ID, the first licenses bore images of their holders.

"Can You Hear Me Now?"

For the past seven years, artist Lise Autogena has been working to re-create a unique feature of World War I-era flying. Yet at first glance, her inspiration looks more like a group of Inca ruins than a piece of aviation technology. The strange, hollow concrete slabs are sound mirrors, the acoustic forerunners of radar. First erected during the Great War, England's "listening ears" were designed to detect the sound of enemy aircraft approaching the coast.

A surviving installation at Denge, in Kent, is typical. "The largest mirror here spans 30 feet in diameter," says Andrew Grantham, a local expert on the huge bowl-shaped structures. "When operational, a moveable microphone could be played across the mirror's focus, to pinpoint the sound of oncoming aircraft"—including zeppelins. The earliest models actually used stethoscopes. Once the listener detected an aircraft, grid patterns etched into the dish's parabolic surface helped identify the line of the craft's approach. Operators wearing headsets monitored the stations from underground bunkers built into the structures' foundations.

By 1930, plans were set to erect acoustic stations every 25 miles along England's southeast coast. The technology was advancing; curving 200-foot acoustic walls could detect aircraft 20 miles away. But the emergence of radar killed the project. So did the increasing speed of aircraft, which reduced the mirror's warning time to seconds, as well as growing "crosstalk" from cars, factories, and other noises of modern life.

Today the big dishes still dot the coastline, a kind of modern-day Stonehenge jutting up from the brambles. "At first, visitors don't know quite what to make of them," says Grantham. Guided tours of the sites draw hundreds, and even a couple of rock bands have featured the mirrors on

MICHAEL RICH

Before radar, England listened for enemy aircraft with remarkably efficient concrete "ears."

Missing in Inaction

Just after 7:00 p.m. on July 13, 2005, a Boeing 747 touched down on Runway 07 at the Thunder Bay airport. For this Ontario paper mill town on Lake Superior, it was the biggest summer story since the black bears returned to loot resident's garbage. The largest airplanes that routinely visit are Air Canada's regional jets and 19-seat Metroliners operated by Bearskin Airlines.

On the ground, the 747's enormous vertical stabilizer could be seen for several miles along the adjacent Trans Canadian Highway. Ground crews were even more surprised by the 747's short landing roll, less than 4,500 feet. Other than air traffic controllers, no one knew it was coming. "This thing literally dropped in our lap," airport business manager Ed Schmidtke told the *Thunder Bay Chronicle Journal.*

The 747 taxied to Maint Air, a fixed-base operator at the airport that usually parks small airplanes. The airport didn't have an air stair tall enough to reach a passenger door, so a ladder was placed under the belly, and the crew, the only people on board, exited through an avionics service hatch.

The flight crew had moved quickly to get the U.S.-registered 747-SP out of Cincinnati. The blue and white jumbo jet was fleeing a stack of unpaid bills for a long list of items, including fuel, maintenance, and contract flight crews. At least one Los Angeles group had paid the owner $800,000 for a charter flight to Poland that was never delivered or refunded. The group was suing for $9 million.

Federal Aviation Administration officials were calling the aircraft's owner, a group headed by the globetrotting Houston-based evangelist K.A. Paul, with questions about maintenance and use. They wanted to know how the owner could offer charter flights without a charter certificate. And two recent trips the 747 had

MARK HUBER

A 747 hides from creditors at Ontario's Thunder Bay airport, guarded by a wannabe Cessna.

taken to Libya and Syria—with only two passengers—had raised eyebrows among U.S. security officials.

Apparently, the FAA's questions were not answered satisfactorily. On July 18, the agency suspended the 747's operating certificate, citing violations of maintenance agreements.

At October's end, the 747 remained at Thunder Bay, with its $2,800 landing fee and accumulating storage fees unpaid. No one has heard from the owner in weeks. The engines' fan blades spin and rattle in the wind and the rudder rocks free. Corrosion has set in and fluids drip from its belly. Maint Air is parking two-seat Cessnas and Pipers under its wings. "Exactly how and where this finishes, I don't know," says Ed Schmidtke.

This 747 is perhaps the most colorful example of a scenario that plays out every day. With the price of jet fuel skyrocketing, marginal and even mainline aircraft operators are pushed to the edge and are parking airplanes they can no longer afford to operate.

Almost half of U.S. airliners are operating under bankruptcy. Within the last three years in the United States, United Air Lines and U.S. Airways together have shed almost 200 aircraft from their fleets. Newly bankrupt Northwest and Delta Airlines between them want to ditch 220 more.

And last September, for a fleeting moment, I wanted to join them. I had parked my Cessna 172 next to the 747 in Thunder Bay and ordered fuel—at $6.16 per gallon. I looked at the bill in my hand, then glanced up at the Skyhawk and the 747. They looked good together.

—Mark Huber

album covers. Yet many are losing ground to erosion. Like the iconic stone heads on Easter Island, the dishes at Warden Point and another at Hythe have fallen over. Grantham spotted one derelict mirror now used as the wall of a farmhouse. An $850,000 grant for archeological preservation in 2003 is helping restore crumbling foundations.

And now the mirrors are set to return. "They almost look as if they were still listening for something," says Autogena, a Danish-born architectural artist who is working with a team of engineers and historians to construct modern versions of the mirrors, this time to foster international dialogue rather than provide tactical warning. Two new dishes, one near Dover and the other near Sangatte, France, will incorporate improved listening technologies, allowing people to speak with each other literally across the English Channel. "Visitors will be able to climb to a listening platform," Autogena says, "and be surrounded by conversations and sounds coming from across the water."

Testing to identify the optimal curvature for the new mirrors has won overdue praise for the originals. Their 1915 designs turn out to be remarkably efficient sound collectors. And through a nonprofit educational group, the Sound Mirrors Project, schoolchildren from both sides of the Channel are participating in the project, fostering an exchange that the original operators of these sentinels could hardly have imagined.

—*Nick D'Alto*

COURTESY MOLLER INTERNATIONAL

Strings attached: The Moller Skycar has never flown untethered. It might make a nice planter for your front yard.

Thanks, I'd Rather Have a Lump of Coal

For a mere $3.5 million (delivery not included), the Neiman Marcus Christmas Book—the ode to the nation's most outrageous examples of conspicuous consumption—is offering the prototype of the Moller M400 Skycar. Says Ginger Reeder, Neiman Marcus vice president of public relations: "We thought the time was right for a flying car."

According to the catalogue, the Skycar is designed to get 21 miles to the gallon (of alcohol), take off and land vertically, cruise in excess of 350 mph, and "elevate individual drivers above the headaches of commuting and the dangers of highway travel." There's just one small problem. Make that one big problem.

The Skycar hasn't yet elevated *any* drivers or passengers. Ever.

Like cold fusion, warp drive, and all-you-can-eat diets, the flying car is a great idea whose time resolutely refuses to come. In 1964, engineer Paul Moller came up with what appeared to be an even better idea to bring personal aviation to the masses—a small vertical-takeoff-and-landing aircraft, which he dubbed a volantor, that incorporated ducted fans. After more than a quarter-century of development and several earlier prototypes, he unveiled the M400 Skycar.

In 1991, the rakish red prototype

PEOPLE AT WORK

The Best Jobs in Aerospace

Carmen L. Prater
United Space Alliance
Space Shuttle Senior Technician/
Spacecraft Control Operator
Kennedy Space Center, Florida

NASA/KSC

Carmen Prater sits in for astronauts in the shuttle Discovery *just prior to the return-to-flight launch last July.*

For a new Spacecraft Control Operator, the night before a space shuttle launch is a truly remarkable experience. SCOs are right in the middle of all the last-minute pre-tanking preparations at the launch pad.

SCOs are also known as "ground astronauts." When performing SCO duties during ground testing, I work with the firing room to perform all shuttle systems checkouts inside the ship just before the launch. Once the orbiter lands, SCOs take it over, "deconfigure" it from flight configuration, and monitor all systems while it is rolled back to the Orbiter Processing Facility.

In my technician role, I perform repairs and modifications to the orbiters in the OPF.

I started out as an aircraft mechanic. After I complete my bachelor's in professional aeronautics, I will work on a master's of aeronautical science in space studies.

I gave my heart and soul to the launch and landing of STS-114, and I intend to be a part of NASA's human spaceflight program and launches to the moon, Mars, and wherever else we can go.

There is no cooler job than this. The only thing I don't like? The mosquitoes here at Kennedy.

landed on the cover of *Popular Mechanics*. Alas, this was, for the next 10 years, the Skycar's most impressive flight. The M400 didn't make its first test hop until 2001. Since then, the one-of-a-kind prototype—the actual item offered by Neiman Marcus—has flown about 30 times, but always while tethered to the ground. And because the eight rotary engines develop so little thrust, the Skycar has never carried any passengers.

Not that Neiman Marcus has a problem with that. "The fantasy gifts are supposed to be about fantasy," Reeder explains. Retail maven Stanley Marcus inaugurated the over-the-top offerings in response to annual calls from broadcaster Edward R. Murrow, who wanted to know what those wacky Texans were buying for Christmas. Since then, fantasy gifts have ranged from his-and-hers Chinese junks to a $10 million zeppelin.

At least a zeppelin flies. What do you do with the Skycar prototype? "We're selling it with the ground control station and data-gathering equipment, so somebody could do his own test flight," says Bruce Calkins, general manager of Moller International, sounding somewhat doubtful. "But we think this is a piece of aviation history, so we'd prefer to see it preserved in a private collection or public museum."

By the way, if you don't want to spend $3.5 million spreading good cheer, you can buy a "My Next Car Will Be a Skycar" license plate holder for $15 directly from Moller International.

—Preston Lerner

Best in Show

At the Reno National Championship Air Races last September, Kent and Sandy Blankenburg's jewel-like 1948 Luscombe Sedan 11A was the overall winner of the 2005 Rolls-Royce Aviation Heritage Trophy, Western Region. Ninety-

JAMES CHAN/ROLLS ROYCE

two Sedans were sold in the late 1940s, at an original cost of $7,000. "Luscombe used many parts from 1948-'49 automobiles, as seen in our Sedan," says Kent Blankenburg. "She was originally designed for farmers, but poor sales caused the company to doll her up for the broader general aviation market." There are less than a dozen Sedans flying today. The People's Choice award went to Danny Summers and his big-dog Douglas AD-5 Skyraider. The National Air and Space Museum, the National Aviation Hall of Fame, and the Reno Air Racing Foundation are partners with Rolls-Royce North America in the National Aviation Heritage Invitational, which was founded in 1998 to encourage restoration of aircraft to original flying condition.

HEADS UP

COURTESY PLANES OF FAME

Days of Infamy: Japan's Aerial Assault
10 a.m. Saturday, December 3, 2005
Planes of Fame Air Museum
Chino Airport
7000 Merrill Ave., #17
Chino, CA 91710
(909) 597-3722
www.planesoffame.org

December's monthly special event at Planes of Fame opens with a seminar describing Japan's offensive aerial operations in the early months of World War II and concludes with a flight demonstration by the museum's Mitsubishi A6M5 Zero fighter, the world's only fully authentic airworthy Zero. Captured on Saipan in 1944, the Zero is still powered by its original Sakae engine.

At each monthly special event, members in attendance, including last-minute sign-ups, may enter a drawing for a free World War II aircraft orientation flight.

Dwight's Spyplane

Type "Supermarine Spitfire" into any Internet search engine and you'll get close to 300,000 hits. The same for "Hawker Hurricane." But try looking for the Westland Lysander, and you'll find a mere 40,000 mentions. Like the Spitfire and the Hurricane, the Lysander was a British aircraft that served during World War II, but the Lysander wasn't quite a dashing fighter. Its top speed was only 212 mph, and it was somewhat odd looking, with gull wings and clownish wheel pants. Its most notable mission certainly kept it out of view: In the dark of night, Lysanders dropped off and retrieved Allied secret agents working behind enemy lines.

The Lysander's cloak-and-dagger history appealed to Dwight Brooks II, who in 1973 began restoring a Lysander at Van Nuys Airport in California. Four years later, Brooks donated the aircraft to the National Air and Space Museum, and in 2004, the Lysander went on display at the Museum's Steven F. Udvar-Hazy Center in northern Virginia. Brooks passed away in 1996, but his son, Dwight Brooks III, remembers why his father was drawn to the airplane. "He wanted to take on a restoration project that would bring something less well known into the scene," he says. "Not another fighter, but something cool and aesthetically interesting. At the time, many of his buddies, especially at Van Nuys, had restored warbirds; there were plenty of P-51s around, awesome restoration jobs. But the Lysander, an espionage plane, must have seemed a bit original at the time."

In 1935, Britain's Air Ministry needed an airplane that could support army troops by gathering intelligence and spotting artillery. The ministry awarded a contract to Westland Aircraft Limited of Yeovil, Somerset. Westland's designers came up with the Lysander, which had good visibility, stability at low speeds, and most important, short-takeoff-and-landing capability. After World War II began in 1939, the Royal Air Force indeed flew Lysanders in support of ground troops, but soon such flights were being made by modified fighters.

In 1942, the Special Operations Executive formed three squadrons to fly missions in aid of resistance movements in occupied Europe, and the slow-flying Lysander, which could land and take off in unlit fields and pastures, was well suited to serve as a spyplane. Westland added a ladder behind the cockpit to ease access, as well as an external fuel tank to extend the aircraft's range. Lysanders made many flights to Nazi-occupied France, supplying British agents working for the French resistance with cigarettes, news from home, and fresh codes.

Other countries flew the Lysander, most notably Canada, which manufactured 225. The Lysander now on display at the Udvar-Hazy Center most likely came off Canada's production line and probably never flew in Europe.

Brooks searched more than two years for a Lysander to restore before finding one in a farmer's field in Edmonton, Alberta. What Brooks found was more of a carcass than a complete aircraft.

After transporting the airframe back to Van Nuys, Brooks plucked parts from other Lysanders to complete the restoration. "The task of obtaining basic information, manuals, the airframes, and parts covered half the world, perhaps 350 letters, 22,000 miles of driving, 5,000 air miles of travel, and well over 500 phone calls," the elder Brooks recalled in a self-published family memoir. Much to his delight, some 4,000 people, including 20 former Lysander pilots, stopped by his

COURTESY DWIGHT BROOKS III (3)

To complete his restoration of the Lysander, Dwight Brooks (above) took parts from other Lysanders, including one he found in North Carolina (left). After the three-year project, Brooks flew the taildragger out of Van Nuys (right).

ERIC LONG

On the morning of July 14, the National Air and Space Museum celebrated the 30th anniversary of the July 17, 1975 Apollo-Soyuz space docking. American astronauts Tom Stafford and Vance Brand and Russian cosmonauts Alexei Leonov and Valeriy Kubasov (standing, left to right, in front of test vehicles for the Apollo command and service modules and a backup docking module) were honored in the Museum's Space Hall (fellow Apollo crew member Deke Slayton passed away in 1993). Event organizers showed a film that explained how the Apollo-Soyuz mission was a symbolic union of the two superpowers during the cold war. Apollo-Soyuz also ended the space race between the two nations, which had begun with the Soviets' launch of the satellite Sputnik on October 4, 1957, and culminated with the landing of U.S. astronauts on the moon in July 1969. "It was a successful attempt to improve communications between east and west," said astronaut Brand.

—Allie Hagerman

hangar to check out the restoration, which kept him busy for three years. "I never saw him work harder on anything in his life," says his son. "He was near to collapse on numerous occasions."

When Brooks, a retired U.S. Air Force pilot and Korean war veteran, wasn't working on the Lysander, he was entertaining guests at his home in the Brentwood section of Los Angeles. Brooks seemed to know everyone in southern California's aerospace community, and test pilots, astronauts, and commercial pilots all gathered for cocktail parties in the bar-equipped wood-paneled den, where 200 model aircraft, most of them assembled by Brooks, hung from the ceiling. A regular at the parties was former test pilot Herman "Fish" Salmon, who made the first flight in the Lysander after the restoration. Many of Brooks' pilot friends would buzz his house before coming over for a visit, and even up to two years after his death, some of his friends still flew low over the house as a way of paying tribute to the good times.

Brooks seemed incapable of idleness, and during the last 20 years of his life he built dozens of radio-controlled model aircraft, donating them to local museums and writing articles about his creations for modeling magazines. Still, he longed to reach a larger audience. Says his son: "There is no question that he would have felt deeply honored to have the Lysander in the Udvar-Hazy Center. Nothing could have pleased him more."

—Allie Hagerman

The Museum's Lysander is painted in the colors of the Royal Air Force's covert Special Duties 138 Squadron.

DANE PENLAND

VISITOR INFORMATION

January 28 Family Day: Apollo 11. Touch a moonrock; see the command module *Columbia*; learn how Apollo astronauts ate, played, and slept in space. Gallery 100, Museum on the Mall, 10 a.m. to 3 p.m.

Curator's Choice
Occasionally a National Air and Space Museum curator gives a 15-minute talk about an artifact or subject of interest at either the National Air and Space Museum on the Mall or the Steven F. Udvar-Hazy Center in northern Virginia. Meet at noon at the gold seal near the Information Desk in the Museum on the Mall or at the nose of the SR-71 Blackbird reconnaissance aircraft at the Udvar-Hazy Center.

Museum on the Mall: Dec. 7, Vintage Airline Posters; Dec. 14, Burt Rutan's Voyager aircraft; Dec. 21, Wernher Von Braun's Space Station Model.

Udvar-Hazy Center: Dec. 1, X-35B Joint Strike Fighter; Dec. 15, Apollo Lunar Spacesuit and Equipment.

Except where noted, no tickets or reservations are required. To find out more, visit www.nasm.si.edu *or call Smithsonian Information at (202) 357-2700; TTY: (202) 357-1729.*

Location The National Air and Space Museum is on the National Mall, along Independence Avenue SW, between 4th and 7th Streets, Washington, D.C. The Steven F. Udvar-Hazy Center is at 14390 Air and Space Museum Parkway, Chantilly, Virginia, near Washington-Dulles International Airport.

Hours The Museum on the Mall and the Udvar-Hazy Center are open from 10 a.m. to 5:30 p.m. every day except December 25.

Food The Museum on the Mall has the Wright Place Food Court, which offers selections from the breakfast and lunch menus of McDonald's, Boston Market, and Donatos Pizzeria. The Udvar-Hazy Center offers burgers, salads, and other favorites from McDonald's, along with muffins, cakes, and specialty coffees from the McCafé. Please note that food and drink must be consumed inside the restaurants; they may not be taken into display areas.

Shopping Both the Museum and the Udvar-Hazy Center shops offer a variety of souvenirs, books, DVDs, models, posters, clothing, and toys. A selection of these products can be purchased online at *SmithsonianStore.com*.

"Something Was Very Wrong"

PAUL SALMON

I knew we were going to crash-land more than an hour before it happened. What I didn't know was whether it would hurt, how much damage the airplane would suffer, or whether the pilot knew what he was doing.

I'd wheedled the promise of a ride out of my new friend Steve about a week before, when I learned that he owned a twin-engine Cessna and flew it on business trips. I'd been in a small airplane only once before, and I remembered it wistfully. Although I didn't know Steve very well, I turned on the charm. Would he take me up, pretty please, and soon?

He flew up to Portland, Maine, from Boston on a Saturday to pick me up. We scrunched into the cockpit and he pointed out the basic controls. I gawked at the instrument panel. He showed me how to read the chart, a mysterious map with markings representing lights and radio towers and topography. I buckled in, and we put on enormous headsets. Suddenly I was an insider, privy to the conversations of air traffic controllers and pilots as they negotiated landing and takeoff clearances. As different voices spoke, Steve would point up in the sky at a speck moving toward us, or over at a big airliner rumbling slowly away from a gate. I loved the notion that the people I was hearing were driving those airplanes.

When we took off, I felt like I was in a tin can. The twin engines sounded too loud. The airplane shook and bounced, and I wondered if Steve could see on my face that my stomach was trying to ascend into my throat.

But as we rose higher, I relaxed. The green landscape spread below me, intersected with curvy blue rivers and lakes like puddles. The full expanse of the landscape and the soft blue sky surrounded me. In half an hour we reached Moosehead Lake. We arced gently around snowy mountains and I bounced in my seat, pointing out other airplanes and lakes and towers. We turned east to Belfast and I gasped at the coast and the sunny blue loveliness of the islands dotting the bay.

We landed in Belfast for a bathroom break and chatted with a young aviator working at the tiny airport. He and Steve talked engines and fueling stations and long-distance flights. I studied the chart on the wall, up to Nova Scotia and down to Boston, and imagined adventures Steve and I could have. I would pack a lunch and we'd fly here, or maybe there. The world of flying was exhilarating and suddenly available to me. When we took off to return to Portland, I was hardly nervous at all. I watched Steve's eyes flicking around the instrument panel as he pulled the airplane's nose up. By the time we were back in Portland—an instant, it seemed—I had extracted a promise for another flight.

As we approached the Portland airport, I was alert but relaxed, enjoying my chance to see the traffic and listen to the air traffic guys. We touched down gently and I knew immediately that something was very wrong—the airplane was tilted way over toward my side, bumping and scraping, everything loud and askew. After only a second or two Steve accelerated and we were back in the air.

The tower guys were in our ears right away, asking what was wrong. Steve thought the landing gear on the right side hadn't extended all the way. He opened a panel on the floor between our seats, then just shook his head and sighed. "I can't get to the landing gear from up here," he muttered. The controllers instructed us to fly by the tower; they had binoculars. We looped around, and they confirmed that the left wheel was out but the right wheel was jammed halfway into the belly of the airplane. I saw an ambulance and a fire truck beside the runway. It took me a second

to realize that they hadn't been there before. A second after that, I realized they were there because of us.

Steve talked with the tower. Apparently some things had to happen before we could land. We had to burn off fuel. Steve was obviously unhappy, but he didn't seem afraid. I considered my options with rational detachment. There were none. I couldn't jump out of the airplane. I couldn't fly the airplane. I couldn't fix the airplane. All I could do was trust Steve.

"Listen," he said. "When we land, the landing gear will collapse. When it breaks, we will slide along on the wing. The plane will be damaged, but I don't think we'll be hurt. Okay?" I nodded. "Before we land, we want to burn all the fuel up so that our tanks are empty. This means that we're going to run out of gas in a few minutes when we use up our first tank, and I will switch us to the second tank." *Okay. If we're going to crash, we probably shouldn't have tanks full of fuel.* I wanted to ask Steve a dozen questions, but his jaw was tight and his brow furrowed. *Let him think*, my numb brain instructed me. I looked out the windows.

We circled over Portland Harbor and I watched big jetliners banking around the same loop we were following. A yellow and red ferry slid across the harbor. I counted three fishing boats heading to sea. When we turned back toward the airport Steve radioed air traffic control. "I think I'm going to take it back to Massachusetts," he told them. "I'd rather have the plane disabled near my mechanic." They cleared him to head south. My detached mind considered the logistics of getting back to Portland.

The sun was low in the sky and its light lit the ocean like a shining gold carpet. It was dazzling. I squinted south and had just identified the dim shadow of Cape Cod interrupting the light on the water when the engines sputtered and died. For the first time since our takeoff I felt chilled by fear, like a hand was squeezing my heart. It lasted a split second. *This is just the planned emptying of the tanks, there's another tank of gas, he warned you about this.* Steve flipped the fuel valve and the engines came back to life.

As I was peering to my right, looking for Portsmouth, Steve called Portland air traffic control again and turned the airplane around. I didn't understand why, and I offered, "Um, you needn't go back to Portland on my account, you know…." He said, "Thanks, but it's not for you. I'd rather land in Portland because the Portland airport is much bigger than my airfield and the fire department there is probably a lot better." I nodded. It took me a couple of beats to catch up with him. *Oh. The fire department is a factor. We want a good fire department. Because we might catch fire.*

We used up the second tank of gas near Portland. When the engine sputtered and died, I felt once again that split second of terror. My stomach had just unclenched when Steve said, "Okay, we're about to land. Here's what I want to do. I want to come in at the slowest possible airspeed that I can fly this plane at and still control it. So I'm going to practice. This means I'm going to slow us down until we start to stall, so I'll know exactly where that line is." I nodded. I could feel the airplane falter and start to lose altitude. I made myself think back to everything I'd ever learned about airflow and lift theory. I remembered a high school physics project on Bernoulli's principle and the aerodynamics of foils. *We won't drop like a stone.* Steve lowered the nose again to stabilize the airplane, then pulled it up again slowly, to the point where the aircraft was just starting to stall. We did it once more. By the third time, my rational brain had walled off the part of me that felt visceral panic.

We were low now, not far from the airport. The controllers' voices crackled in my ears. I could see the runway. The sun was near the horizon and the landscape was in shadow, all blues and hazy purples. Two ambulances and three fire trucks had lined up along the runway, their lights flashing. We were moving very slowly. Steve checked my seatbelt, then asked, "Are you ready?" I nodded. He reached across me, saying, "I'm going to unlatch the door so if the frame deforms on impact, we can still get out." I nodded. It seemed a sensible idea, and only a moment later did my brain recognize the threat. *This metal airplane might deform in the impact. Right.*

And then we landed, and time speeded up. A rough *bumpbumpbump*, and in the next moment the right wheel collapsed. We lurched onto the right wing and it scraped along the runway, making a terrible noise. The wing dragging on the asphalt pulled the airplane to the right. We twisted off the runway and ground to a halt not far from the fire trucks. When we stopped I sat for a beat, looked at Steve, and started to breathe a sigh of relief when he yelled, "Get out of the plane!" It took me a heartbeat to realize the peril wasn't over. A gaggle of firemen undid my seatbelt and pulled me out and away from the airplane. Steve scrambled out behind me.

The firemen seemed almost disappointed when the airplane didn't burst into flames. They stood around expectantly, ready to leap into action. The airport staff crowded around to inspect the damage. Not everyone would have landed so expertly, they whispered to me, impressed. A few feet away, I huddled in an oversize firefighter's coat next to an ambulance while they poked at the wing and talked in the chilly air. I watched Steve, grateful for his unruffled competence, and hoped he wouldn't hold me to the next flying date we'd made.

—*Scheherazade C. Fowler*

The controllers instructed us to fly by the tower; they had binoculars. They confirmed that the left wheel was out but the right wheel was jammed halfway into the belly of the airplane. I saw an ambulance and a fire truck beside the runway. It took me a second to realize that they hadn't been there before. A second after that, I realized they were there because of us.

Cotton Candy, Hot Dogs, and Parachutes

©BETTMANN/CORBIS

Riders wafted over Coney Island's boardwalk in a training device turned amusement park ride.

In the early 1930s, retired naval air commander James H. Strong traveled to Russia to check out paratroop training, a new aviation specialty. As a cost-saving alternative to bailouts, Russian recruits preparing to drop behind enemy lines practiced their descents by parachuting from tall wooden platforms with wires attached to the chutes to guide them back to Earth.

Back Stateside, Strong improved the technology, patenting a steel-frame tower, with arms at the top for suspending the chutes. Each chute was carried up the tower by an electric winch, then guided on its travel to the ground by eight cables attached to the parachute to stabilize its descent. Strong erected a prototype on his estate in Highstown, New Jersey. Passing motorists, spotting the tower above the trees and the white canopies wafting earthward, simply had to know more. To Strong's surprise, the curiosity-seekers were soon clamoring to take rides themselves.

What started as a steely preparation for a new kind of combat showed promise as an unlikely sport. Around the same time, author and publisher George Putnam erected his own 115-foot tower. His inaugural jumper, who pronounced her descent "loads of fun," was his wife, Amelia Earhart.

Capitalizing on this newfound consumer market, Strong designed a graceful tower, 262 feet tall, its mushroom-shaped top suspending a dozen parachutes from a maze of beams. It debuted for rides at New York's 1939 World's Fair and proved a huge success. Among its many aerial festivities was a parachute wedding, the newlywed couple gliding to the ground after being married at the tower's peak.

On the fair's closing in 1940, theme park visionary Edward Tilyou acquired the spire and moved it to Coney Island, where it earned the nickname "Brooklyn's Eiffel Tower." There, amid the cotton candy stands and roller coasters of Steeplechase Park, patrons sat side by side on the ride's bench seats. After the dizzying, 25-story ride to the top, the hook trawling the parachute up the tower disengaged. The riders experienced free fall for a few seconds, then the oversized canopy inflated to its full breadth with a whoosh. After the parachute swayed gently down the wires, shock absorbers in the base of the ride provided a soft, if bouncy, landing. One rider summed up the experience: "They hooked us in, and my father put his arm around me. But I wasn't terrified at all—it was a dream come true." The more adventurous descended at twilight, dropping from the sky into the boardwalk's flashing lights.

But as Hitler's troops continued to drop from the skies over Europe, carnival amusements quickly gave way to Commander Strong's original purpose. By April 1941, three towers, virtually identical to Coney's, were erected at Fort Benning, Georgia. In place of Coney's parasols, Benning's recruits would jump using the Air Corp Test Center's new T-4 parachutes. These were among the first chutes fitted with separate "riser" cords, which allowed paratroopers to steer their descent by pulling on them.

No carnival rides here. "Suspended agony" bettter described the hours of practicing with the risers, all the while hanging from the T-4's notoriously uncomfortable harness. And unlike Coney's big chutes, the little T-4s really plunged down the tower. Dropping from the "dirty arm" (the side of the tower facing the wind) guaranteed an alarming descent, followed by a hard PLF (parachute landing fall), said to build toughness. "We separate the men from the fools," one instructor snarled. "Then the fools jump." The first U.S. airborne divisions were formed by summer 1942.

In the wake of the war it helped win, Coney's parachute attraction would continue to thrill, rising to pop icon status with occasional pop culture silliness (TV's "The Flintstones"even dangled from a Stone Age version). Meanwhile its duplicate towers, still at work in Fort Benning, continued to prepare generations of real paratroopers for jumping over Korea and Vietnam.

Abandoned to rust when Steeplechase Park closed in 1968, then perennially slated for demolition, the parachute tower finally gained landmark status in 1977. Its now-quaint technology rules out putting the ride back into service. But the tower itself, perhaps America's first flight-inspired thrill ride, was cleaned up and painted its original colors in 1992. And last July, the New York City Economic Development Agency chose a winner in an international competition to design a new pavilion at the tower's base.

—Nick D'Alto

From Classic Rock to Classical Jazz…

From LP's to CD's…your favorite music from any era

Discover one of the most timeless designs ever created and pay homage to a great American pastime with the Crosley Conductor.

I remember when the big bands were the kings of swing and Elvis and the Beatles were just starting to revolutionize the music scene. I remember hearing Bing Crosby and Glenn Miller on my parents record player—the one that looked like furniture but sounded great. That player was so beautiful that I look for vintage styles like that for my home today. My love for music has grown from the Beatles and Elvis to Norah Jones and Bruce Springsteen. But today's high-tech audio equipment just doesn't fit with my home's classic style. That's exactly why I want to tell you about the Crosley Conductor.

One of the most timeless designs ever created.

The Crosley Conductor was painstakingly rendered after the original I've come to know and love. The authentic design and audio performance come together to remind me of yesteryear but sound like today. This reproduction features extraordinary finishing touches like brass accents, heavy-duty hardware, and of course the famous Crosley seven step, hand rubbed furniture-style finishing process.

Fully functional for today's music.

If you have classic LP's or digital CD's the Crosley Conductor is ready for your music collection. This musical masterpiece features an analog AM/FM stereo radio, 3-speed record player, compact disc player and a side mounted cassette deck. This audio equipment has that hard-to-duplicate warmth that became so treasured several decades ago.

The History of Crosley Radio

The year was 1920—Powel Crosley founded the company that pioneered radio broadcasting and mass-market radio manufacturing. Dismayed with the $130 price tag for the radio receiver he promised to buy for his son's birthday, Crosley decided to make his own. Upon successfully building a working set for only $35 Crosley was quick to spot the mass market potential. His idea was a simple one. Design a fully functioning radio, meticulously craft each unit with obsessive detail and precise accuracy, and of course add a measure of consideration for the wallet.

Try the Crosley Conductor in your home for 30 days and if your not thrilled listening to your old LP's and the latest CD's that you bought this week, just send it back for a full refund of the purchase price.

Call now to take advantage of this limited offer.

The Crosley Conductor

Three payments of $59.95 + S&H

800-859-2092

NEXTTEN

Promotional Code CRR185-01

Please mention this when you call.

To order by mail, please call for details.

14101 Southcross Drive W.,
Dept. CRR185-01
Burnsville, Minnesota 55337

For fastest service, call toll-free 24 hours a day **800-859-2092**

For information on all our products: ***www.NextTen.com***


TRIDENTS
610
NAVY

by Carl Hoffman Photographs by Tyson Rininger

Why Seahawks have a place in tailhook territory.

Club ROTARY

IT IS LATE AFTERNOON SOMEWHERE IN THE ATLANTIC OCEAN, but it doesn't really matter what time or day it is. Time on the aircraft carrier USS *Theodore Roosevelt* has little to do with the sun or the moon or the hands of a clock, and everything to do with the launch and recovery of aircraft from a ship plowing through the sea at 30 knots. Airplanes come and go 24 hours a day; on the *Roosevelt* they are the sun and moon. The helicopters hovering just off the *Roosevelt*'s starboard side? "We are pilgrims in an unholy land," says Lieutenant Matt Persiani, "the booger on the air boss' flight deck that he just wants to flick off so his jets can fly."

Persiani is one of 23 Navy helicopter aviators in the *Roosevelt*'s HS-3 squadron, which flies six helicopters, Sikorsky SH-60 and HH-60 Seahawks. No jet launch or recovery takes place on the carrier unless one of those six are flying. In every flight cycle, helicopters are the first to take off and the last to land, ready to pluck an unfortunate jet driver or seaman from the drink. "The jet guys think they're badass, but they fly an hour and a half and all they do is fight and bomb," says Persiani, 26. "We fly four hours straight. When the jet guys go to sleep we're on alert all night"—24 hours a day, a helicopter and crew can be in the air within 30 minutes.

In an environment dominated by jets, carrier-based helicopters manage to find a niche (opposite). Commander Tom Fitzgerald (above, standing) oversees HS-3 squadron on the USS Theodore Roosevelt.

The helo pilots never know what their flights will bring. In the past two days of training, Persiani has blown up a mine, hunted submarines, flown a night rescue, and patrolled the waters around the carrier for such terrorist threats as small boats, ready to blow them out of the water. One day he might be flying passengers from ship to ship, another ferrying bombs and garbage, another inserting SEALs deep into hostile territory. "We're the ship's jack of all trades," he says.

The *Roosevelt* and its carrier air group are undergoing sea trials before deploying (exactly where and when is classified), and airplanes are flying in two-hour cycles, each broken by a half-hour pause. The helicopters never rest, however, landing just long enough to take on fuel or a fresh crew.

Whenever a carrier's airplanes are airborne, one helo is always up and poised for rescue, flying within 20 miles of the carrier during the day, 10 miles at night. Every flight carries a diver ready to leap from

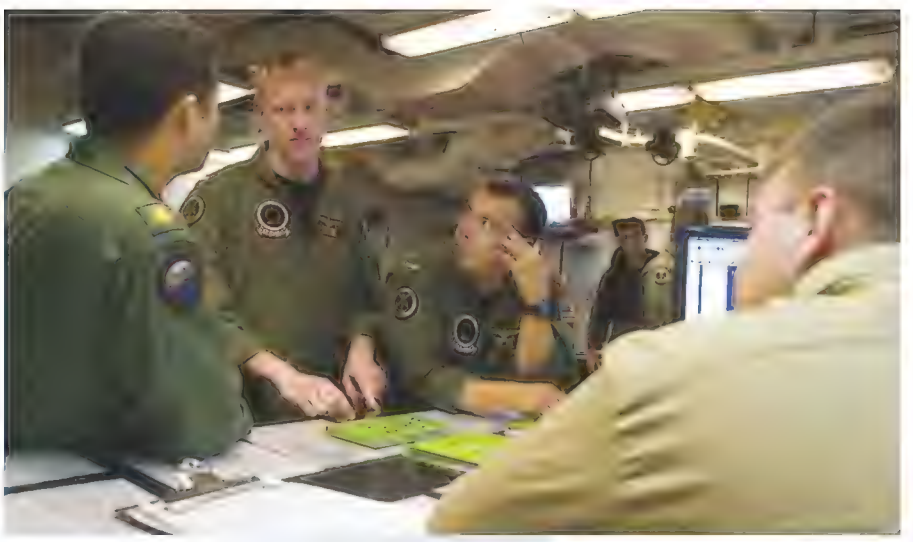
the helicopter to rescue a downed aviator. The other primary mission is killing submarines—perhaps a carrier's greatest threat, especially now, with the proliferation of cheap diesel subs operated by countries like Iran and North Korea. "There are a lot of them, and they're hard to detect," says Commander Tom Fitzgerald, HS-3's skipper. "Especially in local waters where they know all the tricks. One of them could sink a carrier easily, and they cause a lot of anxiety."

In this afternoon's exercises, the carrier air group's destroyer, 20 miles away from the carrier, has made contact with a U.S. sub pretending to be a bad guy somewhere below. Persiani's job is to find it, and, if he can, kill it—"put ball to bat," in anti-submarine warfare lingo. The SH-60F helicopter employs the AN/AQS-13F dipping sonar, which is lowered and retrieved via a 1,575-foot cable. The sub hunt starts after the battle group's destroyer or a Navy P-3 Orion turboprop provides a coordinate. Once the helo is there, hovering 60 feet above the water, the sensor operator in back "dips the dome"—lowers the sonar, a three-foot-long black tube, through a hole in the helo's floor and into the sea. The operator submerges the device to a depth of up to 1,500 feet, depending on intelligence and sea conditions, activates it, and waits for data to display on a small screen. The AN/AQS-13F is a long-range omnidirectional active sonar that works by transmitting and receiving sound waves: Objects within range of the sonar will reflect a transmitted sound wave back to the receiver, and the object's distance is determined by the time it takes the transmitted sound wave to return. The AN/AQS-13F can also determine an underwater target's bearing, as well as the rate at which it is traveling toward or away from the helicopter.

After the initial dip, the SH-60F goes "dip to dip," with the sensor operator repeating the process of lowering the sonar, activating it, retracting it, and dunking it into another spot, trying to close on the submarine based on the sonar returns. The pilot and sensor operator work in tandem to dip as quickly as possible to home in on a prey that might be traveling at about 35 mph. If Persiani wanted to attack an enemy sub, he could launch the SH-60F's two sonar-guided MK-50 torpedoes.

"Okay," Persiani says,

Live ordnance on the flight deck (below) and the pace of flight operations (right) keep the adrenaline pumping.



Rotary-wing crews have their own ready room, where they can plan the day's missions and debrief afterward.

leaning over the back of one of the pilot's leather chairs and facing his copilot, Lieutenant (junior grade) Kevin Chambley, and two other air crewmen in the squadron's ready room. "We'll be on a dedicated [anti-submarine warfare] mission today. There are two Kilos [super-quiet diesel-powered Russian attack submarines] out there. Are you guys ready to go kill 'em? Don't know exactly what our tasking is, but we'll be doing dip-to-dip so the flight maneuvers will be abrupt. Don't know if they'll use countermeasures. We're not dedicated SAR [search and rescue], but the chance always exists; the swimmer deployment will be ten-ten"—with another helo assigned to guard airplanes, Persiani will be called for SAR only if necessary, and will be ready to put a diver in the water at an altitude of 10 feet and a speed of 10 knots.

After the brief, the crew heads up to the searing hot flight deck, crowded with airplanes and dozens of helmeted, goggled figures engaged in the complex symphony of launching and recovering supersonic jets. As soon as the last jet is recovered, a helo lands and Persiani and crew head to the gray aircraft. Its rotors are still turning even as it gets refueled. "No reason to shut down a perfectly working helicopter," shouts Persiani. Often the machines go 14 or more hours without shutting down. As the previous crew exits, Persiani and Chambley climb in front, the two air crewmen in the back, one of them bearing a rucksack containing wetsuit, snorkel, mask, and fins. The two deck crew unfasten the chains securing the helo, pull the chocks from its landing gear, and run to the front of the helicopter, holding them up for Persiani. "I see two chocks and chains," he says, and up we pop.

In the past two days, Persiani has blown up a mine, hunted submarines, flown a night rescue, and patrolled the waters around the carrier for such terrorist threats as small boats.

Moments later we fly 150 feet above royal blue water at 90 knots, hot humid air pouring through the open door. After 30 miles, we see the destroyer. Persiani tries to call it on the radio, but he doesn't get an answer; the destroyer is mute. "I don't know what's going on—maybe they're dead or something as part of the scenario," he says. This is a war game, after all. The carrier, known as "Mom," instructs Persiani to

head 40 miles south to a missile-equipped cruiser. We bank hard and blast off again. The cruiser tells him to stand off to port—it's about to shoot something. But before we do, the carrier radio tells Persiani to go identify another target, but stand off as soon as he does so he doesn't get shot. Off we go again, another 20 miles. Persiani sees it's another cruiser and reports his finding; wary of getting hit, he does not go closer. Get the hull number to be sure, the carrier tells him.

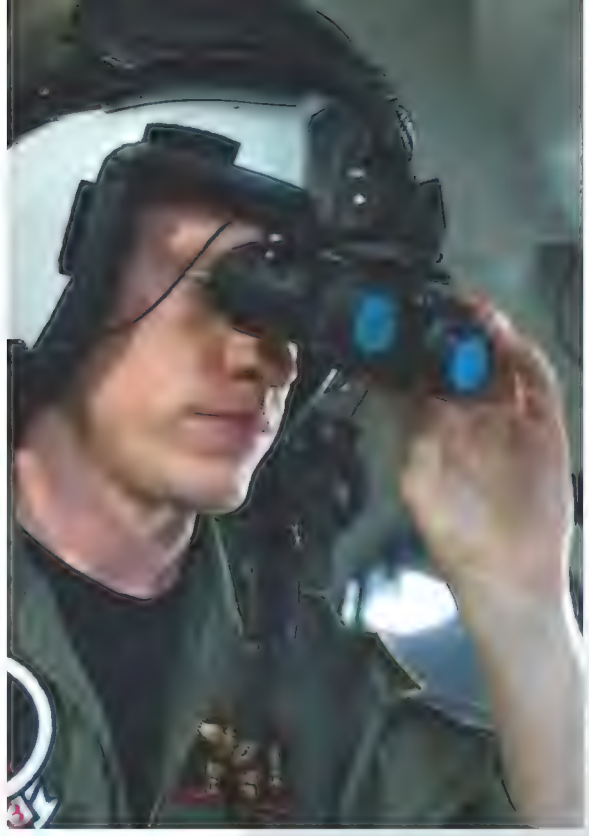
"Roger that," says Persiani. Avoiding the cruiser's weapons, he drops to 70 feet and comes in with the sun at his back. Nine miles is close enough: He IDs the ship and we turn around. Suddenly the destroyer is talking, giving us a coordinate for the sub, another 30 miles to the north. We scream to the spot, Persiani drops low and hovers, and the sonar operator deploys the sonar. The listening device has descended only 30 feet deep when Persiani is told a new coordinate. We reel in the sonar and scream away again. Four miles from the new coordinate, Persiani is told to come back to the carrier. Almost four hours have passed, and the sun is low on the horizon. Persiani is running low on fuel, and after dark he'll need night-vision goggles.

"Crazy out there today," Persiani says in the ready room a few minutes later. "But normal. People know we're available. No one ever tells the jet guys to change their mission from bombing. But we're ready to do anything."

"Crazy out there today," he says in the ready room a few minutes later. "But normal. People know we're available. No one ever tells the jet guys to change their mission from bombing. But we're ready to do anything."

The carrier is a warren of never-ending passageways and small rooms behind closed doors, each one a world unto itself. HS-3's world is the ready room, 23 reclining leather seats lined up in rows by seniority (most senior to the front), each bearing an aviator's name. Two video monitors show the action on the flight deck. White boards displaying the day's mission schedule and weather line the walls. The smell of coffee is omnipresent. Any hour of the day, the ready room is full of pilots talking, studying, and checking e-mail on the room's three computers, helmets and life vests of the crew on alert draped over their chairs. "Way to go Tomcat!" shouts someone, watching the video monitor as an F-14 fishtails and snags in the trap. "Way to foul the flight deck!" It's a young crowd; nearly all but Fitzgerald, the grand old man at 42, are in their 20s.

There are four other rooms just like this one for the fixed-wing pilots; the two worlds rarely interact, except sometimes in the wardroom when jet and helicopter aviators share a meal or game of cards. The helicopter squadron is smaller in every way. There are, after all, just six helos on board and 23 helicopter aviators, versus 22 F-14s and 22 F/A-18s and 65 fighter jocks, each with attendant maintenance and logistics needs. Indeed, there are 1,700 fixed-wing personnel compared to 195 working rotary wing.



Night-vision goggles (above) enable helo crews to fly missions at all hours (below).

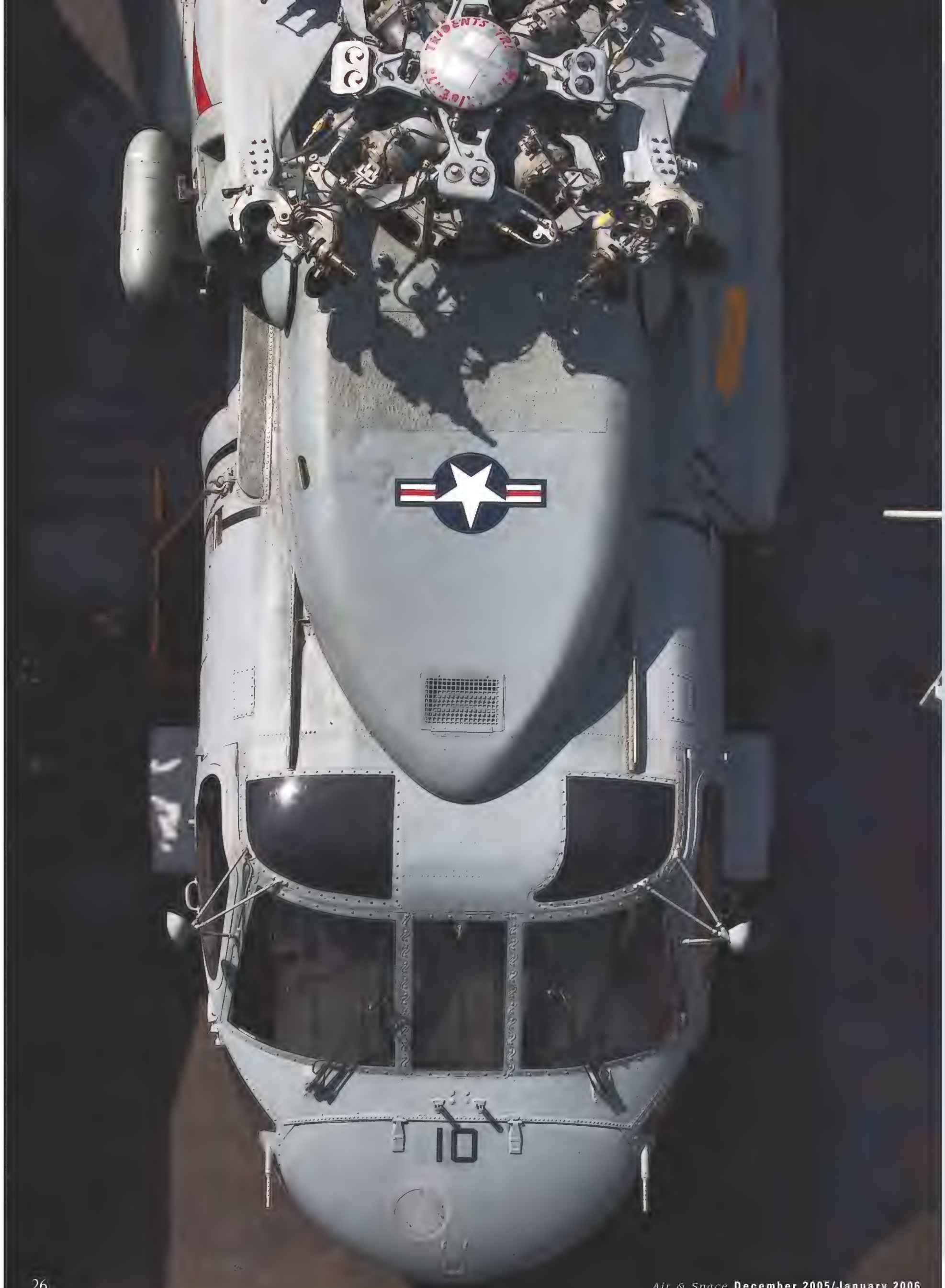
Truth be told, most Navy pilots enter training with dreams of catching tailhooks, not flying helicopters. "Seventy five percent of guys in flight school want to fly jets," says Lieutenant Kevin Colon, 28, cradling a mug of coffee. "But every jet has one pilot and every helicopter two. There are a lot more helicopters in the Navy than jets, and not a lot of people recognize that." Like all Navy pilots, they enter flight school and amass 120 hours in fixed-wing aircraft—T-34s—including aerobatics and formation flying. And then the moment comes. Where they end up is largely dependent on their grades, with higher-graded students getting first dibs on the fewer fighter slots. "You sit at a big round table with an officer, and he opens a file and proclaims your future," says Persiani. "I wanted to fly jets, of course."

Lieutenant Dan Boutros, 26, is unusual: He wanted helicopters from the beginning. "I never liked jets," he says. "In school, I'd spent a month with a carrier helicopter squadron and thought they were the sexiest thing on earth."

"I'd never even set foot in a helicopter," says Persiani, "and three weeks after flying the T-34, I'm flying one. But I have no regrets. None. I'd pick 'em now."

After six levels of rotary-wing training, helo pilots become qualified to fly their most dangerous missions: strike-rescue flights deep into enemy territory, at night, flying the HH-60H version of the Seahawk, which is equipped with laser-guided Hellfire missiles, chaff dispensers, and machine guns. Carrier pilots are the only ones in the Navy to fly the HH-60H, and Persiani spent a month in Fallon, Nevada,

The twin-engine Seahawk is a hotrod of the helo world, able to cruise at 170 mph.


10

and a week in Norfolk, Virginia, training with F-14 Tomcats, F/A-18 Super Hornets, and SEALs and honing his low-altitude skills. "You're flying at night in goggles in hostile territory and it's intense and difficult," he says. "You're right over the trees, almost dragging your wheels on the ground, rotor tip to rotor tip, with the jet guys in F-18s guarding you and F-14s controlling you, and the [need to maintain] situational awareness is almost overwhelming. We don't have a single light on and our goal is to land on a survivor within the arc of our rotors and be gone within one minute. That's strike warfare and only carrier helicopters can do it."

It's just after noon the next day when Kevin Colon and his copilot take off for another flight. We hover off the side of Mom for a few minutes, then dart away, eye a nearby freighter, then check a *Perry*-class frigate against a reconnaissance information card all helicopter pilots carry. "See any other surface contacts out there?" says Colon.

"I don't see jack!" says the copilot.

We ascend to 2,000 feet, flying beneath some diaphanous clouds, then drop to 150 feet.

"Let's go do some SAR!" Colon barks.

The crewman in back grabs a smoke flare, perches at the door's edge, and the helo rears up, slowing to 50 knots. "Cleared to deploy smoke," the crewman says.

"Now, now, now," he says, popping the cap and throwing the flare out. With the crewman in back directing him, Colon drops to 10 feet. Stirred up by the rotor wash, the water is roiling. "Jump, jump, jump!" yells the crewman, simulating the drop of a rescue swimmer. Colon flies to 70 feet, hovers, and drops down to make the rescue.

The 3,400 shaft horsepower delivered to the rotor hub makes the Seahawk (opposite) a mighty protector of a carrier air group.

"The crewman in back runs the rescue," says Colon as we tool back and forth over the blue sea. "If it is night, we overfly, pick a spot, and put the flare in the water to see the downed man and which way the wind is blowing. We're on goggles. The pilot flies and the copilot engages the helicopter's automatic approach system to zero airspeed at 70 feet. Once we're stabilized, we hand over control to the guy in back, who can move the helicopter left or right or forward and backward."

Crews inspect the flight deck for debris that could foul the engines on rotary- and fixed-wing aircraft alike.

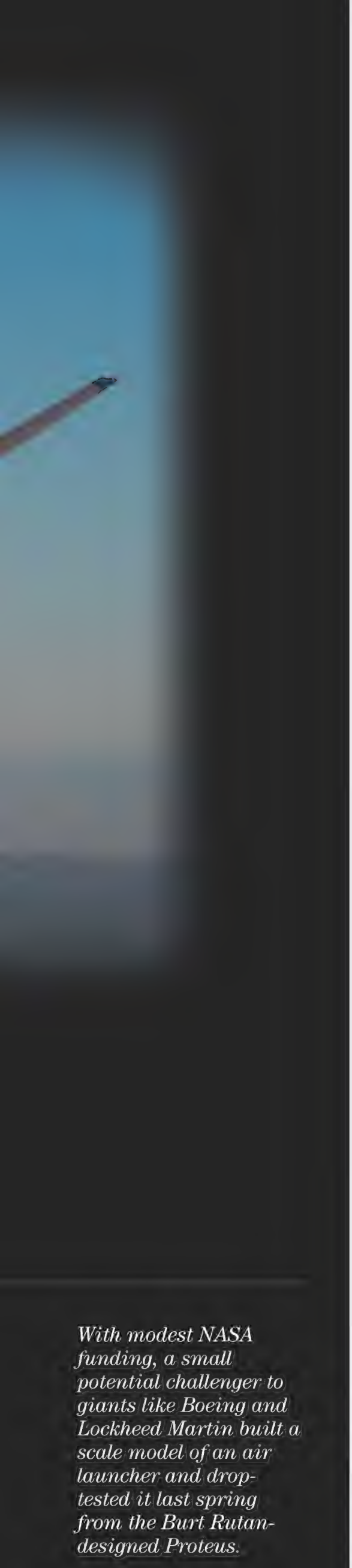
We fly for hours, the pilots chitchatting, the sonar man snoozing, coming close to Mom and flying away again. It is all endless practice, endless waiting. If things go right, they will never do anything real at all, save the occasional hauling of people or cargo. The jet guys may never go to war, of course, but over the last few years they have, in the Middle East and the Adriatic and Mediterranean seas. But jets don't go splash in the water or get shot down very often, and a Navy helicopter has never, ever actually attacked an enemy submarine. Says Tom Fitzgerald: "The day we start killing someone else's subs for real is a very bad day."

"Look," says Persiani later, downing a Coke and dinner in the wardroom, "we may never hunt a real sub, but it's cool and we have to be ready. We have to be true to our roots, but in a lowly lieutenant's opinion we're going to be doing more and more strike warfare." Indeed, as special operations has increased in importance, the Navy is gearing up for carrier helicopter pilots to play a more aggressive role, and the squadron is hoping for an additional HH-60H. Persiani has high hopes that in the Gulf he'll be able to fly from a land base somewhere into hostile territory to insert and remove Navy SEALs, a job that is always done with jets flying support. Despite the ribbing between tailhookers and helo pilots, it's a job that brings the two camps closer together. "We're the only helicopter pilots in the Navy who train with the rest of the jet guys, and we live in their environment and we understand them," says Persiani. "Even if it's hard sometimes, as the S-3 guys say, to look cool in an aircraft with windshield wipers."

Watch This Space

Is t/Space the real deal?

Or yet another startup bound to fail?



With modest NASA funding, a small potential challenger to giants like Boeing and Lockheed Martin built a scale model of an air launcher and drop-tested it last spring from the Burt Rutan-designed Proteus.

LEFT: MICHAEL F. LEMBECK

by Geoffrey Little

IN THE PRE-DAWN DARKNESS of California's Mojave Spaceport, a group of employees from Burt Rutan's Scaled Composites assembles in a hangar around the twin-engine Proteus aircraft, a Rutan design. Strapped to its belly, held by an old bomb rack from an F-4 fighter, is a rocket booster without engines—a drop test article that 90 days earlier was just an idea in an e-mail.

In a few hours the Proteus will release the first of three such test articles to demonstrate a critical step in a new method of air launch. If successful, the dummy rocket will detach cleanly, be pulled upright by a small drogue chute as if to fire, then plummet 25,000 feet and smash into a dry lake bed. "We do wacky things every day," says Scaled project manager Bob Morgan, who's aware that dropping large objects from the sky is unusual even in a startup rocket business.

The fast-moving company behind today's test is actually a consortium of half a dozen smaller companies, including Scaled. T/Space, short for Transformational Space Corporation, was created in 2004 by entrepreneurs Gary Hudson and David Gump, who hope, as their consortium's name implies, to revolutionize human spaceflight by dramatically reducing its cost. With luck and NASA's help, they might just do it. But on this May morning, all attention is on the drop test.

The technique to be evaluated today was masterminded by Hudson's lead flight test engineer, Marti Sarigul-Klijn, a retired Navy test pilot and missile veteran. Sarigul-Klijn built the t/LAD (Trapeze-Lanyard Air Drop) mechanism for today's test from parts he found in a hardware store, an aircraft boneyard, and online. Scaled test pilot Mike Melvill contributed an old bomb rack he scavenged off an F-4 Phantom years earlier. That would do nicely for the trapeze to swing the dummy spaceship down from the Proteus. Then they needed a lanyard to drop it from the trapeze. A car tow strap had just the right load-bearing capacity. Next, a braking mechanism to stop the strap: An off-the-shelf brake from a Honda motorcycle fit the bill. A small wireless modem and a controlling chip with just 10 seconds of memory would supply the commands and broadcast the drop data.

Finally they needed a release mechanism. Existing air-launched rockets like the Orbital Sciences Pegasus use explosive bolts, but Morgan didn't want to attach pyrotechnics to the hull of Scaled's one and only Proteus. So the team developed a pneumatic piston fired by a scuba bottle. For the last few weeks they'd done hundreds of test releases in the hangar, dropping the quarter-scale booster the short distance from the airplane's underside onto a stack of corrugated cardboard.

Their caution was understandable. One of Morgan's employees had brought in a military video of bomb release bloopers, which the crew had bravely watched. It showed bombs flying parallel to airplanes after their release, or bumping into the mothership's fuselage like dangerous suckling pigs, or flying up through wings and rotors.

Before dawn the Proteus, with the dummy rocket almost grazing the tarmac, rolls out of the hangar, taxis, and lifts off quickly toward the test area, half an hour's flight away. For its full-size rocket, t/Space hopes to commission Rutan's company to build a larger carrier called the VLA, or Very Large Aircraft, with a gross weight of near-

ly a million pounds and a payload capability of 150 tons. The wingspan would be 320 feet.

Today, though, it's the much smaller Proteus. After the aircraft circles the lake bed, the flight engineer starts a countdown. The airplane flies out level, the bomb rack swings down, the chute deploys, the strap snaps out nine feet to pitch up the nose of the rocket, and the motorcycle brake squeezes the strap, pulling the rocket up into the correct position. A small drogue chute deploys next, which pulls it out farther from the airplane. After a heartbeat, the dummy booster is released. Normally the chute's riser would be burned off, but on this first engineless test, they stay attached a hair too long. The booster noses down toward Earth rather than up toward space, and hurtles to the desert floor. For Sarigul-Klijn, watching from a chase plane, it's an upsetting moment.

A week later, after tweaking the chute's release mechanism, Sarigul-Klijn decides to watch the second test from the ground. This time it works flawlessly: After the release, the test rocket is suspended magically upright in the sky. On a real launch, the engines would then fire, and the t/Space rocket with its four-person crew capsule would blast off toward space.

If engineering were the only worry, the odds of that happening would be fair, maybe even good. But Gump, Hudson, and the rest of the t/Space team know that if they want to see their plans through, they have to fight other, perhaps tougher, battles: in Washington and on Wall Street. Ultimately they envision a self-sustaining commercial rocket business carrying freight and tourists into Earth orbit and beyond for a fraction of what today's Deltas and Atlases cost. In the near term, though, they'll be competing for crucial NASA contracts to deliver supplies—equipment, food, water, and possibly astronauts—to the International Space Station later in this decade. Whoever wins those contracts will have a head start on the rocket revolution. And whoever doesn't may be out of the game.

They'll be competing for crucial NASA contracts to deliver supplies—equipment, food, water, possibly astronauts—to the International Space Station in this decade. Whoever wins those contracts will have a head start on the rocket revolution. And whoever doesn't may be out of the game.

David Gump (top, left) is t/Space's business mind; astronaut Jim Voss (right, testing the CXV seat with the Auburn University students who designed it), its voice of experience.

The road to orbit is littered with big-talking startups that promised to shake up the launch business—if only NASA would sign on as a guaranteed customer. Each ended up disappointed or bankrupt when the agency balked, delayed, or changed its mind. This time NASA swears it will be different, and that it genuinely wants to nurture a commercial launch sector that can undersell even the Russians (who charge a low $67 million for a three-seat Soyuz flight to the station). Why? Because the government wants to save its money for bigger things.

"We want to get in the exploring business," says Neil Woodward, an astronaut currently pulling duty at NASA's Washington headquarters as deputy director for Constellation Systems, the developmental arm for the new moon-Mars exploration program. "Trying to get up to Earth orbit all the time distracts us from going on to the moon, which is what we really want to do."

It was NASA, in fact, that bankrolled t/Space's drop tests this year, under two separate $3 million development contracts, as part of its Concept Evaluation and Review Program aimed at sussing out non-traditional approaches to everything from launch to designing moon bases. For that kind of money, the agency usually gets only reports and viewgraphs—not flight

OPPOSITE: © IAN WHITE; LEFT: MICHAEL F. LEMBECK

TRANSFORMSPACE.COM

Then-NASA contracting official Mike Lembeck, on hand for the drop tests, called the event "a good first step to a reliable air launch system."

tests. The contracting official overseeing t/Space was Michael Lembeck. "In order to get out of the theological and into the practical, they were going to have to actually do something," he says. "We decided to let t/Space loose to give them some credibility."

Lembeck, who flew in the chase plane himself and took pictures on the second drop test, called the Mojave demonstration "a good first step to a reliable air launch system." Without picking favorites, Woodward agrees. "[T/Space] has done very good work for us, and it really behooves us to be able to take advantage of any capabilities that emerge out of that sector."

Let the competition begin.

T/Space was kick-started into being by the NASA grants, almost over the objections of one of its founders. Gary Hudson was happily working at his latest company, AirLaunch LLC, which in 2003 had received development funds from the Defense Advanced Research Projects Agency (DARPA) and the U.S. Air Force to develop faster, cheaper access to space for small military satellites. The Air Force also hoped that Hudson's rocket, called QuickReach, could evolve into a hypersonic vehicle capable of delivering a 12,000-pound payload a distance of 9,000 miles in two hours.

Hudson is no newcomer, having been in aerospace engineering for 35 years, and is largely self-taught. "I'm old enough to have used a slide rule," he says. He doesn't care for computers, preferring calculators (he has 20 hand-helds scattered around his house) to spreadsheets and working with pencil, paper, and whiteboards until he's ready to hand his designs over to a computer operator for conversion to electronic form. He sees engineering as a mix of science and art.

Over the years, Hudson has founded more rocket companies than he can easily recount. The best known of them was Rotary Rocket, which employed Marti Sarigul-Klijn as one of the test pilots and got as far as hover-testing its odd, propeller-topped Roton rocket before folding in 2000 (see "I Survived the Rotary Rocket," Feb./Mar. 2002). Hudson describes himself jokingly as a misfit in the aerospace business. "I've failed, and failed, then failed again, then succeeded a little," he says.

David Gump is another serial entrepreneur. He started several space business news publications in the early 1970s, just as the Apollo era was ending. Then in 1989 he founded Lunacorp, which aimed to commercialize space through schemes like having customers pay to drive a rover on the moon, or launching boy band singer Lance Bass to the International Space Station, or filming the first commercial in space for Radio Shack (one of the deals that actually went through).

T/Space exists because of Gump, who now serves as its president. He was working as a consultant to AirLaunch in its Reston, Virginia office when he learned that NASA might request proposals for non-traditional approaches to developing its new Crew Exploration Vehicle (CEV) for the moon and Mars. Gump had to work hard to convince Hudson to apply. "They're never going to give anything to the likes of us," Hudson said. He was wary of NASA, having watched earlier talk about commercial "alternative access" to the space station come to nothing. But Gump prevailed, saying it was "a different crew, a new NASA." Hudson had just finished a second-round proposal to DARPA for AirLaunch, and finally agreed it was worth the extra time to write another 30 pages for NASA.

Their proposal made bold promises to launch four people into Earth orbit for the phenomenally low price of $20 million, and included plans for transportation to the moon. The actual work—everything from ground services to propulsion—would be done by a network of subcontractors that included Rutan's Scaled Composites.

Hudson remained pessimistic about their chances, not even bothering to incorporate t/Space after submitting the proposal. Then, in July 2004, soon after DARPA awarded him an $11 million Phase II contract to design and test systems for a fast, cheap rocket, he got another call from NASA. He phoned Gump. "Are you sitting down?" he asked. "We got both!" T/Space was launched, and Hudson and Gump had to scramble to incorporate and get their paperwork in order that same day.

While Gump started fleshing out the t/Space concept, Hudson used the new

money to advance his technical design, including the propulsion system. The engine would be built on contract by Tim Pickens' new Alabama-based company, Orion. Pickens had helped design the innovative, self-pressurizing nitrous oxide- and rubber-burning engines for X-Prize-winner SpaceShipOne.

As with that engine, simplicity was essential for t/Space. No turbopumps, no supercooled hydrogen—just propane fuel and liquid oxygen, which are easy to handle and store on the ground. Pickens built a 20-ton test stand at Mojave, not far from Hudson's abandoned Rotary Rocket launch pad, and fired the new rocket engine in July. Hudson stood about 300 feet away. "It's a beautiful exhaust," he says, "Almost transparent." What's more, the engine started and stopped cleanly. Over the next year Orion will conduct dozens more test firings under the DARPA contract, which will be key to t/Space's future.

Depending on NASA's as-yet-unspecified requirements for resupply flights to the space station (how much cargo? three passengers or four?), the same engine could be scaled up or flown in clusters. Hudson quickly worked out the rest of the design. To differentiate their resupply vehicle from NASA's larger CEV, which will be built for the longer-duration moon voyages, t/Space dubbed it the Crew Transfer Vehicle, or CXV.

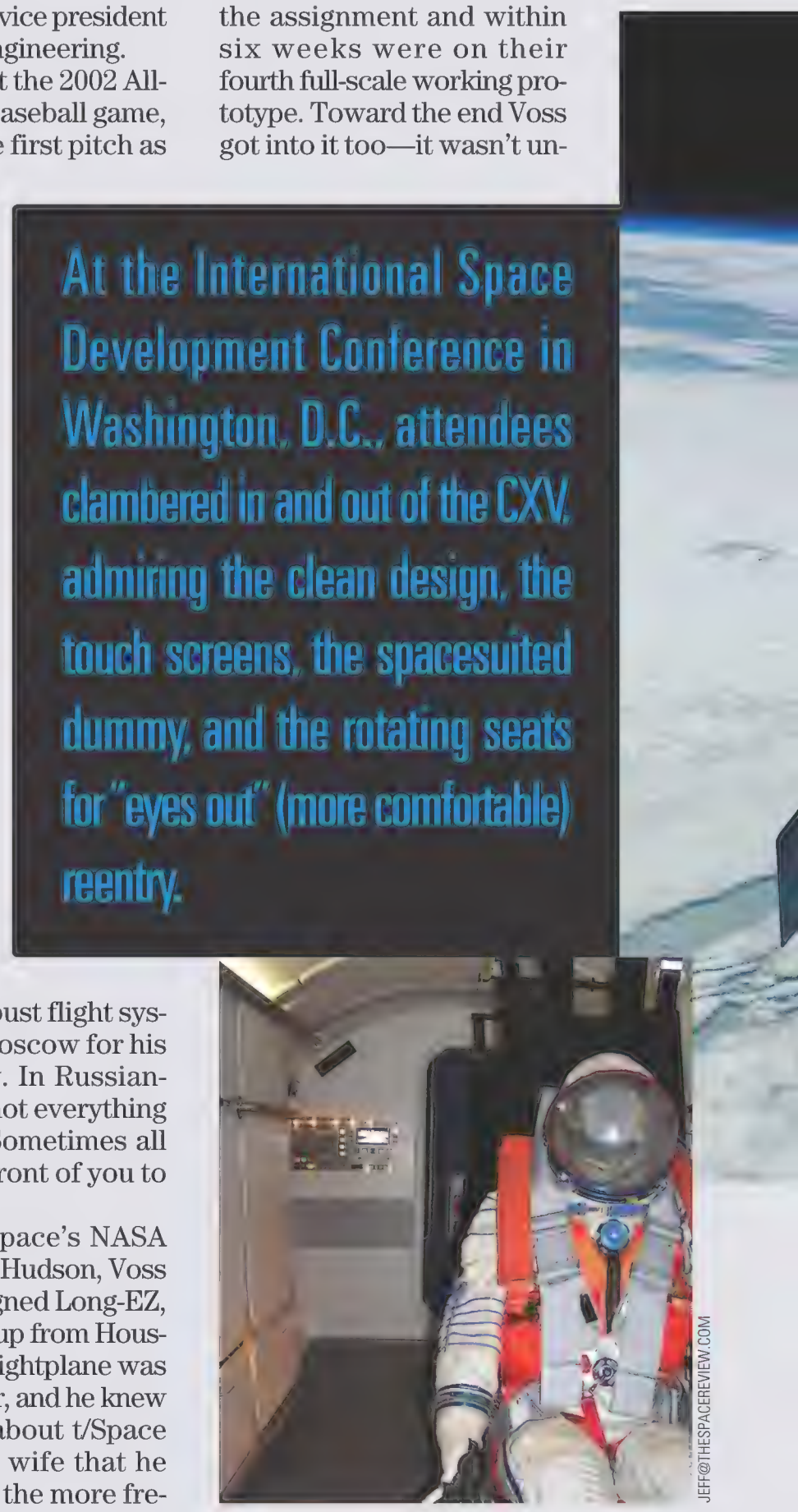
Hudson's design for the CXV was inspired by the snub-nosed Corona/Discoverer capsules that reentered Earth's atmosphere more than 400 times in the 1960s, carrying top-secret pictures taken by spy satellites. To protect against the fiery reentry, the CXV fuselage will be smooth, like the Corona's, with no protuberances and an aft hatch. As further thermal protection, t/Space plans to use an insulating silicone tile developed at NASA's Ames Research Center for Mars-bound spacecraft. The design adds an external water misting system to reduce fuselage temperatures further.

Last spring t/Space unveiled a full-scale (14-foot diameter) mockup of the CXV at the International Space Development Conference in Washington, D.C., which showcased many of the "emergent" space companies. Attendees—among them Buzz Aldrin and other space veterans—spent the next few days clambering in and out of the CXV, admiring the clean design, the touch screens, the spacesuited dummy, and the rotating seats for "eyes out" (more comfortable) reentry. As they climbed the stairs to the capsule, the most recent t/Space hire stood near its base, ready to discuss the vehicle he'd had a hand in designing. A genial, salt-and-pepper-haired southerner, veteran astronaut Jim Voss had joined the t/Space team in March as vice president for human spaceflight engineering.

Gump first met Voss at the 2002 All-Star Futures exhibition baseball game, when Voss threw out the first pitch as part of a Lunacorp promotion. (The same ball was later flown to the space station and "thrown out"—via TV—as the first pitch of that year's World series.) When t/Space was gearing up in 2004, Gump called Voss and asked him to come aboard as a consultant. Since leaving NASA in 2003, Voss had been happily teaching aerospace engineering at Auburn University in Alabama, and had no desire to work for an aerospace giant and "manage a program on paper." But the five-time astronaut liked the simplicity of t/Space's plans. He had learned to appreciate simple, robust flight systems while training in Moscow for his 2001 space station stay. In Russian-built systems, he says, "not everything is done automatically. Sometimes all you need is a switch in front of you to turn on and off."

While working on t/Space's NASA proposal with Gump and Hudson, Voss would fly his Rutan-designed Long-EZ, which he'd built himself, up from Houston or Alabama. But the lightplane was not good in heavy weather, and he knew he was getting serious about t/Space when he convinced his wife that he needed a new Cirrus for the more frequent commutes to Washington. Voss is now in charge of all human-related spaceflight engineering.

The CXV's nylon seats were prototyped and built in three months by his undergraduate engineering class at Auburn, working with a small t/Space grant. "They're essentially ready for production," Voss says proudly. The original task was to design a seat that rotated 180 degrees for reentry, but the students got hooked on the assignment and within six weeks were on their fourth full-scale working prototype. Toward the end Voss got into it too—it wasn't un-



At the International Space Development Conference in Washington, D.C., attendees clambered in and out of the CXV, admiring the clean design, the touch screens, the spacesuited dummy, and the rotating seats for "eyes out" (more comfortable) reentry.

JEFF@THESPACEREVIEW.COM

usual to see him sewing or working metal late into the night with the undergrads, says Jonathan Metts, the student project leader.

Gump values the ex-astronaut's store of knowledge. He says that when Voss is in a meeting with NASA "and someone across the table says 'I don't think that's going to work,' Voss quietly replies, 'Well, I've had some experience with that, and I believe it will.' "

JEFF@THESPACEREVIEW.COM

The full-scale test article used for the parachute ocean drop included a water tank for ballast and had the same center of gravity as the real deal.

TRANSFORMSPACE.COM

Supplying the space station is only the beginning. Eventually Gump and company hope to run a full transportation service to Earth orbit and the moon, with their blunt-nosed CXV capsule docking with NASA Crew Exploration Vehicles. Left: A Russian spacesuit inside the CXV mockup at a recent trade show.

Now Gump needed a player who could win at the Washington power game and provide access to decision makers. Having left the White House Office of Science and Technology Policy, 34-year-old Brett Alexander was looking for a job in the private sector. One of the authors of the Vision for Space Exploration that President Bush announced in January 2004, Alexander remembers typing the words "retire the space shuttle fleet by 2010" and feeling the full weight of the words as he did so, having witnessed *Columbia*'s first launch in 1981 as an 11-year-old.

From then on he wanted to be in the space business. After getting a master's in aerospace engineering and working at several space-related jobs, he landed a staff position in Bill Clinton's White House science office, then survived the transition to a new Republican administration. After the *Columbia* disaster, Alexander stayed on to help write the new space policy before joining the private sector. With a wife and child and new house in Fairfax County, Virginia, he had his eye on a prime aerospace/military contractor or a satellite company like XM satellite radio. Then a friend, another policy consultant working with Gump, urged him to come to Reston to check out a new company with an unusual name, t/Space.

Alexander knew a bit about Gump and Hudson, who had been knocking around the edges of the space business for years. He looked at their Web site and listened to his friend's pitch at t/Space's small rented offices in Reston. His initial reaction was different from Voss'. *These guys are crazy*, he thought. Most commercial space companies had failed, and here was one more saying it could launch people into orbit in under four years, for less than half a billion. He told his wife about t/Space, then put them out of his mind.

But like Voss, Alexander didn't want to end up working on a paper program for a huge contractor. His wife would ask him every few weeks about "that small company" which she said "sounds

like your dream job." In February 2005, Alexander joined t/Space as vice president for government relations.

It remains to be seen whether this assembled "supergroup" of talents—the astronaut, the marketing guy, the rocket designer, the policy expert, plus the celebrity (Rutan) in a supporting role—will be the ones to finally ignite the spaceflight revolution. They aren't the first to promise low-cost launches, nor the first to assemble a team of aerospace veterans in hopes of winning NASA business. Another rocket startup, Kistler Aerospace (see "Rockets for the Rest of Us," Feb./Mar. 1998), tried a similar strategy and even spent millions to buy proven Russian rocket engines, but ended up in Chapter 11.

Another contender is Elon Musk, who made a fortune founding and selling the online purchasing service PayPal; he is further ahead in developing his Falcon rocket, which was due to debut this fall. Musk's company, SpaceX, has also won NASA development funding, and has a more traditional ground-launched rocket of its own design and manufacture. Starting small, with small payloads, Musk aims to get the cost to orbit down to $1,000 per pound, or one-tenth the current price.

Gump says that t/Space, and a few other "alt.space" efforts like Musk's, are like small, intelligent mammals running around among the dinosaurs, the traditional aerospace contractors that supply NASA. Recently, he says, some of the big companies have been "rubbing up against us, to get a little of that mammal smell." If t/Space and the others make something happen, the aerospace contractors may end up coming to them, or incorporating their ideas.

First they'll have to survive, though. For now, it's not certain how NASA means to encourage the upstart companies, who typically don't have the experience or the money to compete with the big boys. Says NASA's Neil Woodward, the paperwork alone can be crushing for a company with a small staff, like t/Space. "They don't have dozens of people in accounting and personnel to deal with the huge amounts of data that we would normally be required to ask for under the federal acquisition regulations," he says.

Fast-moving entrepreneurs like Hudson have generally preferred working with the Department of Defense. "DARPA buys smart," he says, basing its contracts on results and performance goals rather than on pages of detailed specs that have to be followed to the letter. He's hopeful NASA will convert to that practice as well.

TRANSFORMSPACE.COM

Two of three parachutes worked as advertised during an August test; so did t/Space's propane/oxygen engine, fired for the first time last summer.

Already t/Space, Kistler, and the rest of the alt.space crowd are frustrated that NASA has taken months to put out its call for commercial proposals to resupply the space station. "We're as frustrated as they are," says Woodward, who pleads for patience in an era of upheaval for the space agency. This time, he says, NASA wants to get it right, and not end up doing more harm

than good to the emergent commercial sector. "NASA is a huge organization. We deal with large systems, large sets of requirements, lots of money. It's very easy for us to pervert the market, in a totally unintentional fashion. Something that's not a big deal to us is a huge deal to a smaller company."

Still, the agency has to satisfy itself that any unproven company can deliver what it's promised, safely, for the advertised price. And it needs a Plan B in case the new guys don't come through—the CEV is in fact being designed to take people and cargo to the space station (as well as to the moon) just in case. Regarding safety and reliability, Woodward expects that t/Space and others will fly its own crews and payloads first to prove that the system works. "When it gets to the point where they're flying NASA personnel—astronauts or scientists or what have you—or interacting with a NASA facility like the space station, we would have to look at the 'human rating' rules. But if they have a well-designed vehicle and a well-tested vehicle, that's not as large a hurdle in most cases as a lot of people make it out to be."

Last August, t/Space chartered a Sikorsky S-61 helicopter flying out of Crescent City, California, and took a full-scale, water-ballasted 8,000-pound CXV capsule up 10,000 feet over the Pacific. Then they dropped it to see how the chutes would open and how the crew and craft might fare.

DARPA

NASA Administrator Mike Griffin, who has experience in the nimbler Pentagon space procurement culture as well as the commercial sector, said during a news conference in September, "NASA has not had at its upper levels a manager or an administrator more supportive of commercial enterprise than I." Griffin has publicly stated that he will initiate a commercial market for the station resupply service and that he will "place some bets" (probably by investing R & D funds) on this market. He would prefer that proposers "have skin in the game," shorthand for bringing in private equity, to show financial health, because one or two NASA missions a year won't be enough to sustain a business. But that may not be an inflexible requirement. Says Woodward, "It would be best if NASA were agnostic on this. I don't care where you're getting the resources that you need. I don't care if you're getting them because no one in your company is working on salary, or you've got a rich brother-in-law, or you've got a [venture capitalist] who's willing to stake you."

As of mid-October, the t/Space team couldn't predict exactly what NASA will request, or when. But they know what they'd like to do. If funded in early 2006, they'll propose a first manned test flight in early 2009 (ahead of NASA's CEV), using their own crews. They'll fly multiple times in orbit to prove to NASA (and all other comers, including potential space tourists and astronauts and scientists from other nations) that their system is safe, then contract it out at $5 million a seat—eventually less.

"People have spent billions trying to do what [t/Space] hopes to do for millions," says one observer, Lori Garver, a former NASA policy official and now a space analyst at DFI International in Washington. "But Gump and Hudson are in it for the long haul. Both of them have made personal sacrifices in their lives to try to make commercial spaceflight happen."

Another former NASA official, now working at one of the established, or "heritage" (read: dinosaur), aerospace contractors, thinks that the t/Space price projections—$20 million a launch and $500 million to develop the entire system—are optimistic. "You can demo anything once or twice," says the official, who asked not to be identified. But "when they need to scale up, they will come up to costs that may be comparable with the offerings of the major contractors."

Hudson, Gump, Voss, and Alexander relish the opportunity to prove him wrong. With the last of their $6 million stake from NASA this year, they decided to do one more test. Having demonstrated their air launch release mechanism, fired their engine (for DARPA and the Air Force), and mocked up the capsule design, they elected to test the reentry. Last August, they chartered a Sikorsky S-61 helicopter flying out of Crescent City, California, and took a full-scale, water-ballasted 8,000-pound CXV capsule up 10,000 feet over the Pacific. Then they dropped it to see how the chutes would open and how the crew and craft might fare.

Gump was in Crescent City for the test, but the rest of the team was working other jobs. Voss and Alexander were in D.C. for a rare bit of face-time with the NASA administrator. During their meeting, the test results came in from California. Gump reported that two of the three chutes had opened, and that the capsule was intact and being towed back to the harbor for inspection. Hearing the news, Griffin said to his guests that two out of three wasn't bad. "Shows you've got some redundancy built into the system," he said.

With a NASA administrator like Griffin, and with the shuttle about to retire, perhaps the planets really are aligned this time for a new kind of launch business.

During aviation's Golden Age, a period when the primary piloting professions in the airlines and the military were for men only, women learned that they could make their mark and earn fame by competing in air races.

The CONTENDERS

PHOTOGRAPHS BY CAMERON DAVIDSON

A sisterhood of pilots united by competition.

Passenger (left): Erica Cochoff
Acworth, Georgia

Pilot (center): Sophia Payton
Clearwater, Florida
"I like competing against the best lady pilots in the United States who come from all walks of life.... I took my 17-year-old great niece as a passenger. She was able to...meet all these talented ladies and at the same time have a geography lesson."

Pilot (right): Marilyn Patierno
Port Orange, Florida

Place: 1st
Aircraft: Cessna 172 Skyhawk

Air races open to women date back to the Golden Age of Aviation, in the 1920s and '30s, when organizations such as the Ninety-Nines and talented fliers like Louise Thaden and Blanche Noyes showed the public that gender knows no speed limit. In 1947 two women flew in a race that a year later became the All-Woman Transcontinental Air Race, popularly known as the Powder Puff Derby, a name coined by popular humorist Will Rogers. The race was designed so that smaller and lighter aircraft could compete on an equal basis with bigger, faster ones.

On June 21, 2005, Purdue University in Lafayette, Indiana, which offers a degree in aeronautical engineering, launched a competition steeped in that great tradition. Forty teams departed from the university campus on a 2,100-mile course ranging across the Midwest and returning to its starting point. The race also made use of a traditional handicapping formula that corrects for differences in horsepower and speed. The corrections enabled the pilots to compete based upon the skill with which they used winds and weather, and the accuracy of their navigation, not on the speed of their airplanes.

Contestants came from different regions and different generations; many senior pilots paired up with juniors. And among the pilots was at least one aerospace executive: Gretchen Jahn, chief executive officer of Mooney Aircraft.

Photographer Cameron Davidson captured in these portraits some of the participants' competitive spirit, their resolve, and the bond that united them in flight.

—The Editors

Pilot (right): Barbara Goodwin
Kalamazoo, Michigan
"As a flight instructor, I race to learn new cross-country skills to share with my students throughout the year. The camaraderie with other racers can never be forgotten."

Pilot (left): Heidi Moore
Fort Worth, Texas
"I came to compete in the 'Biggest and Best Air Race Classic Ever' hosted by my alma mater, Purdue University."

Place: 38th
Aircraft: Piper PA28-140 Cherokee

LOUISE MCPHETRIDGE THADEN COLLECTION, NASM, SI83-2124, SI83-2118, SI832132, SI79-15073, SI83-2122, SI83-2145

Pilot (left): Gretchen Jahn
Kerrville, Texas
"Racing is the exciting challenge of getting the most out of the airplane, working as a team, reading the weather, and a lot of luck."

Pilot (center): Ruby Sheldon
Phoenix, Arizona
"The Air Race Classic is priceless—it's good to have old memories stirred and make many new ones. The new ladies that start each year bring many smiles to us old veterans."

Passenger (right): Julie Filucci
Frederick, Maryland
"I learned so much from flying with these experienced and interesting pilots. The best parts were listening to stories from earlier races and flying that some of the pilots had done decades ago."

Place: 10th
Aircraft: Mooney Ovation2 GX

Pilot (left): Marge Thayer
Mesa, Arizona
"I compete because it is one of the greatest challenges I have every year. And getting to see my fellow competitors is like a big family reunion."

Pilot (right): Helen Beulen
Mesa, Arizona
"The [race] is the ultimate opportunity to experience the true freedom and joy of flying over our beautiful country. Not to mention the camaraderie and competition."

Place: 5th
Aircraft: Cessna 182RG Skylane

Pilot (right): Mary Creason
Grand Haven, Michigan
"[We] race to build confidence and become better pilots; to expand aviation horizons; for fun, food, and fulfillment; for joy, camaraderie, excitement, and therapy."

Pilot (center): Gloria Apple
Grass Valley, California
"No matter what each racer scores, the flight builds self-confidence and an intimate bonding that comes from a team effort."

Passenger (left): Sally Creason
Grand Haven, Michigan

Place: 13th
Aircraft: American General AA-5B Tiger

LOUISE MCPHETRIDGE THADEN COLLECTION, NASM, SI83-2144, SI83-2111, SI83-2147, SI83-2108, SI83-2116, 00170744

North American F-100D Super Sabre

First flight:	May 25, 1953, during which test pilot George Welch took the YF-100A prototype supersonic.
Powerplant:	One Pratt & Whitney J57-P21; 16,000 pounds thrust with afterburner
Gross weight:	38,048 lbs.
Top speed:	926 mph
Number built:	2,294

The six U.S. Air Force aircraft that make up what is known as the Century Series—the North American F-100 through the Convair F-106—were the hottest jets of the cold war. Products of the mid- to late 1950s, they were members of the second generation of jet fighters—post-North American F-86 Sabre class and pre-McDonnell Douglas F-4 Phantom class. The epitome of "pointy jets," they capitalized on early X-plane research, particularly into the aerodynamics of supersonic flight, and on the development of more powerful and efficient turbojet engines, and thus attained speeds approaching Mach 2 (the Lockheed F-104) and later exceeding it (the F-106). All were originally designed as interceptors, nuclear strike aircraft, or long-range bomber escorts, with the exception of the F-100, which was designed for day fighting and ground support.

NORTH AMERICAN F-100D SUPER SABRE

The first production aircraft capable of Mach 1 in level flight, the F-100 was largely based on North American's F-86 Sabre, the MiG-killing star of the Korean War. The Super Sabre, nicknamed the Hun by its pilots, was designed as a MiG hunter, but by the time it began service, during the Vietnam War, the McDonnell Douglas F-4 Phantom had taken on the air superiority role and the F-100 was relegated to serving as an attack aircraft supporting ground troops. Here, in this painting by John Kocon, a flight of two F-100Ds has arrived over a U.S. ground unit engaged with the enemy. The U.S. unit has marked its position with purple smoke, and a forward air controller has fired a phosphorus rocket to mark the enemy's position with white smoke. One aircraft has begun to break right in preparation for rolling in to deliver ordnance according to the FAC's directions.

More Century Series portraits will appear in upcoming issues.

Frozen IN

DC-3s and -4s fly for the coldest airline

by Tom Harpole / Photographs by Clark James Mishler

A Douglas DC-4 Skymaster starting at 40 below zero is a colossal event. Engines crank, whine, and cough before beginning to rumble in unison, louder than a parade of unmuffled Harleys. The exhaust from the 72 cylinders of the four Pratt & Whitney R-2800 engines streams into the frigid air and immediately creates an icy fog. By the time all four engines are firing, a crystalline haze obscures the rear half of the airplane.

The distinctive roar of a DC-4 is routine in Yellowknife, Canada, headquarters of Buffalo Airways. In an average year the family-run airline, which has been flying since 1970, hauls 6,300 passengers on scheduled flights, runs 1,200 charter flights, and delivers 11.5 million pounds of freight to villages across Canada's Northwest Territories, an area nearly twice the size of Texas. The company operates 11 DC-4s and 12 DC-3s, the largest flyable fleet of those aircraft on Earth. But what really sets this airline apart is that owner Joe McBryan and about a dozen of his pilots fly them in winter temperatures that keep lesser mortals on the ground.

Every morning McBryan flies a DC-3 load of passengers from Hay River, at the south shore of the Great Slave Lake, 140 miles north to Yellowknife, the capital of the Northwest Territories. The city boasts about 15,000 of the Territories' total population of 17,000.

During January Yellowknife has only six hours of sunlight a day. The town's residents live the rest of the

The residents of Canada's Northwest Territories depend on Buffalo Airways to deliver supplies in brutal conditions. Owner Joe McBryan (below) has a penchant for vintage airplanes that keeps his company airborne.

time under mercury vapor lights that glow in the fog. Despite a handful of 12-story buildings, Yellowknife feels like an isolated border town.

The Northwest Territories needs an airline because its residents cannot rely on any year-round roads. Scattered in the high arctic vastness surrounding Yellowknife are dozens of Canadian Indian communities, fishing shacks, hunting lodges, and mining operations. Short runways, many unlit, provide the only link to the goods and services needed to sustain life. On McBryan's evening flight to Hay River, a wizened Inuit woman explains: "We used to go by dogsled. Now we move through the air."

McBryan, 61, is clean-shaven and gravelly voiced and sports a 1950s pompadour. He admits that his disposition isn't exactly accommodating, and he deflects interviews. "There's been too many stories about me," he says. "Talk to the pilots and mechanics. Talk to my sons. I've got cat boxes to empty." But his reverence for his fleet of airplanes, many of which are older than McBryan, gets the better of him. He can't resist talking about them.

Pilot Ken Bews admires the view of Canada from the cockpit of a DC-4.

"Rooms full of women built these planes during the war," says McBryan. "Rosie the Riveter built one hell of an airplane. If they made airplanes these days out of the alloys that they used back when these DC-3s and -4s were built, you could fly them well into the 21st century."

"It is the 21st century, Dad," his 22-year-old son Mikey chides. "Buffalo Joe," as the elder McBryan is widely known, smiles wryly.

Cost versus benefit, the heartless equation that sidelines old equipment, is calculated differently at McBryan's airline. "None of our freight haulers are less than 60 years old," Mikey boasts. "We also own the last DC-4 built."

But the pride of the fleet is the *Arctic Distributor*, a 61-year-old DC-4 that has spent nearly 70,000 hours in the air. Built in 1944, the old Skymaster served in the Berlin Airlift before becoming American Airlines' flagship. Qantas owned it for a few

Buffalo's daily flights include delivering freight to communities lacking winter roads, like Tulita.

years, dubbing it the *Pacific Trader*, then Malayan Airlines flew it, after which it ended up in Latin America.

"She's the highest-hour DC-4 ever," Mikey says, an articulate teddy bear of a man who manages charter flights for the airline. "Which means she's probably the highest-hour plane in history."

The airplane now hauls heavy loads into short landing strips, a task that uniquely suits the DC-4.

When Joe acquired the airplane, he named it after the steam-powered stern wheeler on which his father, Red McBryan, worked as a teenager. The riverboat *Arctic Distributor* delivered goods to communities along the Mackenzie River and Arctic coastal villages during the five to six weeks in the summer when the river was ice-free. Today, the Buffalo Airways DC-4 puddle-jumps the same river route to the same settlements that Red's steamboat visited 70 years ago, when fuel was cordwood.

Around Yellowknife's snow-whipped airport, the thick fog partially obscures the collection of hangars big enough to house 737s. Inside the biggest hangar in the Northwest Territories, Joe McBryan prowls around his airplanes in a beaver skin hat and arctic coveralls. He seems overdressed. It's warm enough in the hangar to paint, which a couple of his pilots are doing, layering the Buffalo Airways aquamarine livery on a welding cart.

When Buffalo Airways pilots aren't flying, they sweep, mop, answer phones, clean parts, paint, load freight, and generally do Joe's bidding. Suddenly a bell begins ringing and the four-story-high doors open slowly as a mechanic in a "mule" starts pushing the *Arctic Distributor*, registration C-GPSH, out the door. It's 10:00 a.m., and the air temperature is -41 degrees Fahrenheit. Within three minutes the hangar is the same temperature as the wild white yonder, and within another minute another DC-4 has been tugged inside the hangar. The great doors rumble closed as soon as the 117-foot wings clear, and a couple of 20-ton airplanes have swapped places at a cost in lost heat, according to Joe, of a thousand Canadian dollars.

The extreme temperatures shape every decision made at Buffalo

Rod McBryan restores airplanes bought at auction with parts from the airline's large parts inventory.

Airways. "Companies reflect the personality of the boss," McBryan says. "The boss up here is the weather."

But everyone working for Buffalo Joe acknowledges that he is the man in charge. Any employee who doesn't measure up to the unforgiving environment—and to McBryan's insistence on safety, heedfulness, and propriety—won't last long at Buffalo Airways.

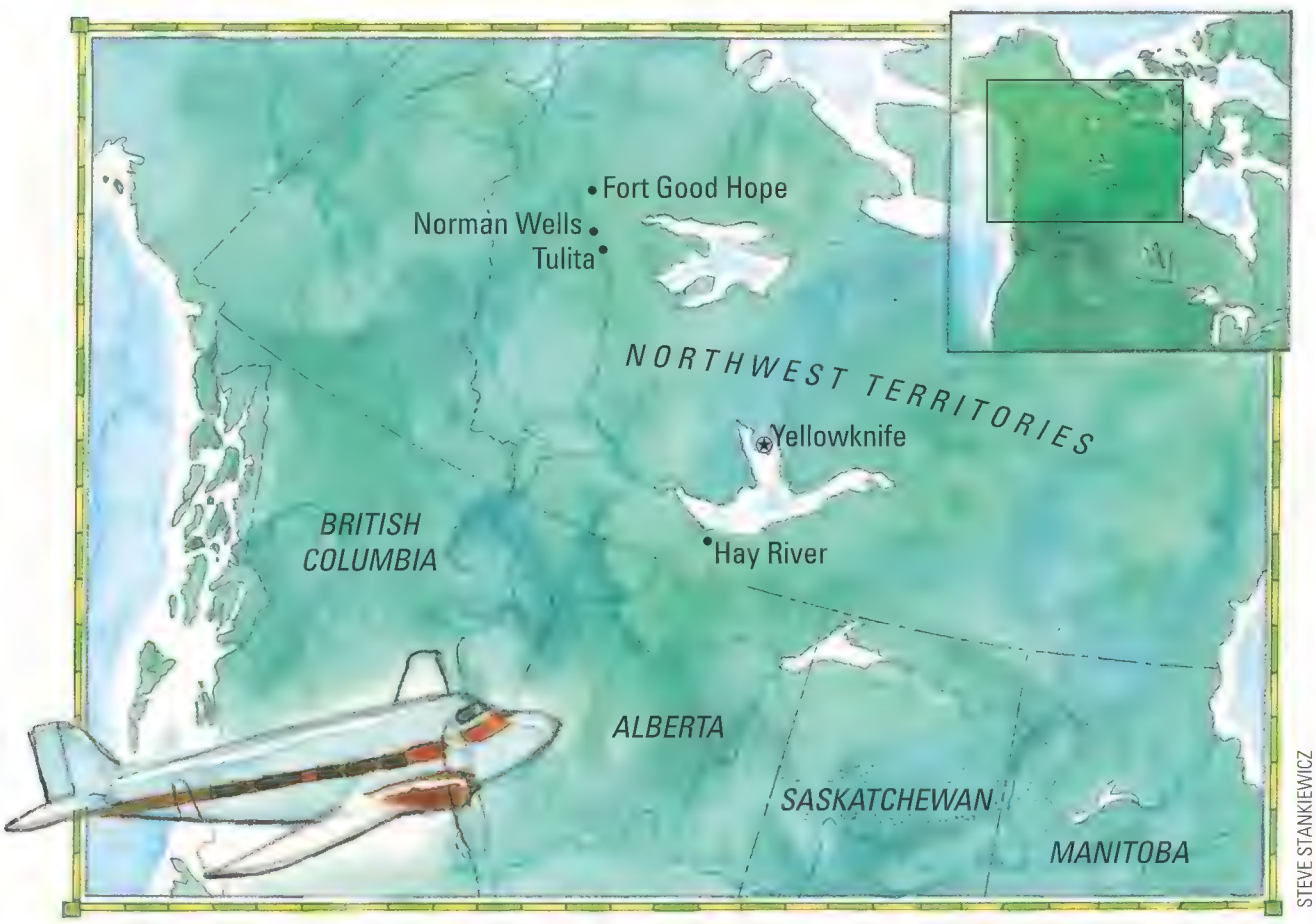
"Don't take his every word as gospel," Mikey says about his father, with a grin. "Once he told a reporter that the cockpits are so cold that his teeth ached, so he had them all pulled."

Every human activity undertaken in the Arctic is made more difficult by the many layers of clothing required. Upon contact with the –40 degree air, exposed skin begins freezing immediately.

When Ken Bews, Buffalo's chief pilot, prepares for a morning freight trip up the Mackenzie River, he dons heavy fleece long underwear, track pants, another fleece undershirt, a wool flight vest, another pair of wool pants, and a heavy work jacket.

He wears a beaver skin hat, but when he flies, he switches to a heavy wool one that doesn't restrict his peripheral vision.

When handling freight on the ground he wears leather mitts over thinner gloves and, like the rest of the crew, packs himself into coveralls that seem to reduce normal mobility to less than half. The crewmates toddle, looking as though they are holding oranges in their armpits.



STEVE STANKIEWICZ

Gloves render hands unfeeling and clumsy, so in flight Bews and copilot Peter Woodbury try to go barehanded. While airborne, they wear athletic shoes rather than their felt-lined boots so they can feel the response of the rudder through the pedals.

At 6 a.m. Bews, Woodbury, and flight mechanic James Dwojak arrive to warm up the *Arctic Distributor* for a grocery run up the Mackenzie Valley. When the airplane was put to bed the night before, all four engines were hooked up to heaters and wrapped with quilted covers. The rest of the airplane is frigid, however, so the crew fires up two Frost Fighters: 250,000-BTU, diesel-powered space heaters with dirty yellow hoses the size of culverts that blow hot air into the cabin and cockpit. There are 600,000 BTUs of heat pouring into the DC-4, enough to warm a dozen three-bedroom homes.

Mechanics at work on the last Skymaster ever built, a veteran of World War II and the Berlin Airlift.

After the spectacle of the start, Bews rolls out toward the taxiway. Woodbury monitors the right wingtip, which barely clears the 14-foot-tall berms of snow plowed away from the hangar apron. Bews repeatedly feathers the props as he taxis because the oil in the prop hubs is coagulated like, well, molasses in January. The pilot loudly worries about stiffened lubricants blowing seals.

"It takes extra power just to taxi when we're this cold," Bews says. "Another three degrees colder I wouldn't want to do this."

On takeoff, the icy mist in the old airplane's wake expands like a living thing, rising from the ground, swirling and thickening, becoming a linear cloud 40 feet high along the length of the runway. "We can shut down the airport for half an hour until the fog dissipates," Bews suggests, a hint of glee in his voice as he retracts the landing gear.

Four minutes after takeoff, when Bews has 68,000 pounds of airplane and cargo moving through the air at 2,800 feet, he throttles back to 50 percent, burning 1,600 pounds (approximately 267 gallons) of aviation gasoline per hour, fuel that is all but unavailable in the high Arctic.

The airport at Norman Wells is the last place on the Mackenzie River that still sells avgas, which can be delivered only via truck along an ice road in the winter. By late summer, stocks of the fuel are often short, and the fleet of DC-3s and -4s will be grounded due to the scarcity.

"We're the only piston pounders left up here," Bews says. "All the other aircraft that haul freight and passengers are turbines, and they burn Jet A or B. Like the rest of the world, we're just hoping the fuel keeps flowing."

A flight engineer pulls insulators from cowlings during a stop. Even brief exposure can harm engines.

Every breath the pilots exhale turns to fog in the cockpit, and Bews's headset mic keeps freezing. He removes it and thaws it on the windshield defroster every ten minutes. On this trip the Janitrol cockpit heater is working at about 30 percent capacity, and the 250,000-BTU cabin heater must be devoted to keeping the cargo from freezing. "There's vegetables back there," he says. "The perishables get the heat."

On this morning's run, the sun rises about an hour after the 9 a.m. takeoff. The rays come in sideways, as though the heavens were tipped over. The landscape becomes painted with a palette of pastels—tributaries and sloughs braided turquoise, the snow-blanketed tundra in tones of cream. Stubby spruce trees cast light violet shadows.

The landscape around the Mackenzie and its environs is soft, worn rock. At three billion years old, some of the oldest exposed rock on Earth is found in the Northwest Territories. The area's surface gold lured miners at the start of the 20th century, and since the 1990s diamond mines have been profitable, despite the remoteness and weather extremes.

Pilot Kelsey Boll is not even half as old as some of the airplanes she flies.

During the six hours of mid-winter light, today's miners, pilots, and other Arctic habitués work under peach- and salmon-colored skies. As the day goes on, the clouds coagulate into streaks of crimson and deep blue.

When arriving at remote Arctic airports, every effort must be made to preserve the heat in the engines after they shut down. At the first stop, in Deline, James Dwojak opens the cargo door even before the big airplane slides to a stop on the ice. When the airplane is at rest, he lowers an oily one-inch-thick rope attached to the doorframe and slides down to the ramp.

Hustling across snow-packed ice to the belly hatch, he grabs four insulated "doughnuts," four-inch-thick, three-foot-diameter covers for the openings in the engine cowlings. Dwojak moves awkwardly, shoving the covers between the propeller shaft and the cowling, which he can barely reach. After stuffing quilted blankets in all four air intakes, he backs into the wind, lights a cigarette, and watches Woodbury lower a stepladder from the cargo door. Several snowmobiles towing basket sleds pull up, and the cargo is quickly thrown out the big rear door.

At the next stop, Norman Wells, named for its nearby oil fields, Bews parks as far from the terminal building as possible to avoid leaving puddles of oil where people walk. By now all four engines have left copious oil streaks along the chord of the wings. The fuel truck pulls up to top off the wing tanks. The seals on the truck's hose connections have frozen, and fuel leaks out under the truck by the gallon. In what looks like a well-practiced move, the truck driver uses paper towels the size of tablecloths to soak up spilled fuel that hasn't percolated into the ice. The air crewmen look on, rolling their eyes at one another.

The crew makes two more stops, first at Fort Good Hope, less than 50 miles from the Arctic Circle, and another during the return trip south, at the hamlet of Tulita. By 4:45 p.m. it is completely dark. The crew sees no lights on the ground except those of a solitary semi truck plying the ice road where it crosses the Mackenzie River above Great Bear Lake.

On the return to Yellowknife, a cowl flap on the number-four engine won't close, causing cylinder heads to cool to the point that Bews must shut it down. At 2,500 feet the engines are running so cold that Bews again comments that the thickened oil may cause another one to fail.

"We can fly the Four home empty on two engines, no problem," he says reassuringly and issues a quick laugh, forming a cloud of vapor that hits the windshield defroster and disappears.

At the end of the eight-hour, 1,030-mile Mackenzie Valley flight, suffering through deliveries of 12 tons of cargo in and out of four

airports at sub-zero temperatures, *Arctic Distributor* needs maintenance. In the number-three engine, which used 10 gallons of oil in the first half-hour of flight, a breather line froze, then thawed, reducing the engine's consumption to an acceptable 2.5 gallons of oil per hour.

But the generator on that engine is not working either. And the number-two engine's left-hand magneto is not delivering enough spark to the plugs—not "getting the juice to the engine," Bews notes.

The fuel nozzle on the Janitrol that heats the cockpit has been running at about 30 percent capacity all day, and the pilots and mechanic are chilled through. They spend the next half-hour—in a wind chill of 66 below zero—putting the *Arctic Distributor* to bed after its long day of labor.

Chief mechanic Roald Sorenson stands before the nosewheel well of a DC-4. His staff can swap out an engine in only a couple of hours.

In 1980 Joe McBryan went bankrupt, as did most of the Northwest Territories' mining operations he served. "If you weren't broke in those days, you hadn't been trying very hard," he quips.

He sold a fleet of helicopters and turbine and piston airliners, holding on to one DC-3 so he could start again. As diamond discoveries in the region began to add up, he was able to re-form a fleet of old piston-engine airplanes. Most operators moved to turbines, but McBryan stayed with what he knew and loved.

Today he runs a thriving business with his family. His 33-year-old son Rod, a slim man with a quick mind, is Buffalo's maintenance director.

One reason McBryan was able to rebuild his fleet is that Rod knew what to look for at auctions. "I can spend a day at an auction, look at a dozen planes and pick out the best one," he says.

There are certain flaws that predictably accrue in the old airplanes, but not everyone can see them. Given a couple of hours, Rod says that he can survey any DC-3 or DC-4 and know within a few dollars what it will take to get it flying again.

Keeping a fleet of 60-year-old airplanes flying requires a huge parts inventory. Joe McBryan could measure his cache of DC-3 and -4 parts in acres. He's been building his inventory for 30 years, to the point that he's had to rent several hangars in order to house it. With this accumulation of parts, McBryan would rather pay mechanics than buy new airplanes.

A few years ago Joe McBryan sent his brother, Ronnie, and mechanics Roald Sorenson and Cliff Dyson to an Aero Union airplane graveyard in California to bring back three DC-3s. Ronnie McBryan, 44, is a handsome, hefty mechanic with a reserved personality.

He has spent more than half his life maintaining his brother's DC-3s and -4s. California didn't suit him. "It rained a lot in California," he says. "We were wet. I missed the frickin' snow and being dry."

"Ronnie and the boys amazed everyone," recalls Rod. "Those planes had been parked for 12 to 15 years. We paid $35,000 apiece and spent another $40,000 to get another DC-3 ready to ferry home."

Rod explains that it takes another $250,000 or so to get such aircraft ready for continuous use. "We've looked at Convairs and Hawkers and Dash 8s," he says, "but you're talking five million bucks and you can't put skis on them, eh?"

Ronnie and fellow mechanics Sorenson and Dyson can swap engines out of a DC-3 or -4 in a couple of hours. To keep the fleet ready, they often just pull an engine and replace it with a rebuilt one, giving themselves time to rebuild the down engine in the shop.

"We've got 200 Pratt & Whitneys in rotation," Rod McBryan says. "Dad's got more parts for these old planes than the African countries that still use them."

Buffalo's corps of winter pilots are about the age of the first pilots to fly the stout airplanes during World War II.

Pilot Kelsey Boll, 27, says the pay is only okay, but learning multi-engine airplanes is invaluable.

"The DC-3s and -4s don't do much

[of the work] for you," she says. "These are busy cockpits. We rack up hours sticking ourselves out there in some challenging weather and planes."

As Boll and the other young pilots add hours to logbooks each week, they seem to be in denial about the decreasing supply of avgas in the high Arctic. Like Joe McBryan, they hope the fuel will still be available when the airplanes are 80 years old.

"The physical art of flying an airplane with your hands and feet is going away," Joe McBryan says with a shrug. "Kids grow up now playing computer games and they don't want to go back to pinball. These planes are pinballs.

"The people who designed these planes have passed on. The people who built them are probably gone too. They can rest in peace knowing that they designed and built the most successful propliners in the history of aviation. As long as we can keep buying avgas, we'll keep this going.

The Arctic Distributor *refuels near a Fokker F-28. Unlike jet fuel, avgas is a rare commodity in the Arctic.*

Things are changing faster all the time."

Call it an anachronism, or nostalgia, but while Buffalo Airways remains Joe McBryan's airline, the roar of Pratt & Whitney engines will resonate across the Canadian arctic.

"He loves flying, it's simple," Mikey says. "A lot of people think he keeps the whole deal going just so he never runs out of old airplanes that he wants to fly."

Inside the Buffalo Airways hangar, a DC-4 shares space with two Canadair CL-215 firefighting craft.

London, May 31, 1915. The moon has set and a cold north wind brings the promise of heavy weather. It's a night to seek shelter, yet hundreds of people made bold by curiosity have spilled into the streets or found a rooftop perch. They speak in whispers or silently gaze up into the darkness, ears cocked to pick up the distant drone of engines, which has already been reported by listening posts on the east coast of England.

A searchlight beam pierces the sky and is instantly joined by several others, all warping into odd angles where they're blocked by clouds. For a fleeting second, one of the beams touches the underside of a silvery, cigar-shaped object. The beam slides past, then snaps back. The rest quickly converge on the spot, their white tips locking onto the ghostly intruder.

With the airship exposed, the big guns of anti-aircraft batteries ringing London go into action. Flashes light the horizon and booming sounds shatter the silence. The response—from German Zeppelin no. LZ38, a million-cubic-foot airship under the command of Hauptmann Erich Linnarz—isn't long in coming. The crew begins dropping 3,000 pounds of conventional and incendiary

WHY DURING WORLD WAR I ENGLAND COULDN'T SLEEP

NASM (SI NEG. #76-17153)

MIDNIGHT

Long before Europe fell into war, Germany was exploring the military use of airships. In 1906 Count Ferdinand von Zeppelin managed a successful test of his LZ3 (opposite), and soon after the German war ministry started buying zeppelins. But even in peacetime, they were dangerous: The L2 went down in 1913 (right) when its hydrogen gas ignited during an altitude test.

LIBRARY OF CONGRESS PRINTS AND PHOTOGRAPHS DIVISION

RAIDERS

by Nicholas Nirgiotis

bombs, their dull thuds followed by explosions that make the ground tremble, setting fires and collapsing buildings. Shrapnel from the anti-aircraft shells rains down, pelting buildings and pedestrians and adding to the pandemonium.

The aerial assault by a lone zeppelin raider that night in 1915 was the first in a series of attacks on London, launched to crush England's will to fight during World War I. Londoners had no doubt read newspaper accounts of earlier raids that had set nerves on edge in coastal towns, beginning with Great Yarmouth, on the Norfolk coast, on January 19, 1915. But those attacks were intended for naval bases, docks, troop camps, and factories making war goods. The London raid had a different psychological impact. Although property damage was minimal and only seven people were killed, the English now knew they could no longer count on the sea surrounding their kingdom or on their powerful navy to protect against attack. Even the heart of the empire, hundreds of miles from the frontlines, lay exposed to the horrors of war.

Well before the August 1914 beginning of combat, as both sides cranked up their military machines, the German navy had been building a

fleet of large, advanced airships—referred to as zeppelins after their creator, Count Ferdinand von Zeppelin, a career army officer who had been advocating the use of lighter-than-air craft since the 1890s. Despite the count's plan that the airships be used "for the observation of hostile fleets and armies but not for active participation in actual combat," the German military routinely boasted about the zeppelins' range and bomb-carrying capacity. To accommodate the growing fleet, Germany constructed more than a dozen large bases, mostly on the North Sea coast, each with revolving hangars so the airships could be pointed into the wind at launch.

When war finally broke out, the question was not whether but how soon Germany would unleash its new weapon on England. The emperor, Kaiser Wilhelm II, at first resisted aerial bombing for humanitarian reasons. But he finally agreed, with the stipulation that Westminster Abbey, St. Paul's Cathedral, the Houses of Parliament, and royal palaces were off limits—Wilhelm was, after all, related to the British royal family.

What had helped change his mind were the heavy losses in the trenches of the Western front and the "hunger blockade" of German ports by the superior British navy. Peter Strasser, the energetic and discipline-minded commander of the Naval Airship Division, argued to his superiors that "England can be overcome by means of airships, inasmuch as the country will be deprived of the means of existence through destruction of cities, factory complexes, dockyards, harbours and railroads." The raids, Strasser hoped, would force the British to shift troops and guns from France to protect their homeland, and would demoralize soldiers at the front when they learned their families were suffering under the fury of aerial attack.

Moonless nights were ideal for the raids, since the defenders could not spot zeppelins approaching in the darkness. Raiders lifted off from seaside bases in early afternoon, crossed the English coast at dusk, arrived over their targets around midnight, attacked, and headed for home before daybreak. Since the airships' navigational devices were primitive, the crews relied on railroad tracks, the glow of city lights, or the soft sheen of rivers and lakes to guide them to their targets.

Weather was the wild card. Cloud cover made navigation a nightmare, and unexpected storms could damage airships or cause them to drift off course. Strasser responded by building a string of meteorological stations along the German coast. While weather predictions were generally accurate for lower altitudes, upper atmosphere forecasts were useless.

"Leaving England forty minutes after we had started the bombing," Captain Ernst Lehmann recalled in his 1927 book *The Zeppelins*, "we ran into another heavy snow squall, and the wind became a hurricane. At one time it gripped the L11 and bore her

BELOW: NASM (7A45000); RIGHT: ZEPPELIN MUSEUM FRIEDRISHSHAFEN

The navy airships were based at hangars like Nordholz, Alhorn, and Tondern (above, in 1917) on Germany's North Sea coast, from which they could strike English targets. Most were built at Friedrichshafen, near the Swiss border, the probable site of the LZ3 in the 1909 photo at left.

NASM (SI NEG. #93-4218)

straight up 3,000 feet. When she settled back again, the tail steering fins were jammed. Before we could balance the craft she again was tossed up for more than half a mile. Finally we got our ship on an even keel by shifting the crew back and forth in the gondola, and held her there until the damage was repaired."

The first raiders flew at an altitude between 3,000 and 8,000 feet—out of range of anti-aircraft guns and safe from the fragile and underpowered British fighters, like the Royal Aircraft Factory BE2c that rose to challenge them. Once over their target, the zeppelin crews dropped parachute flares to blind the gunners below, or ducked into a cloud or fog bank to hide from their pursuers.

Flying a zeppelin was more like sailing a ship than piloting an airplane. The captain stood, binoculars around his neck, with the watch officer and control surface operators in a small (seven- by nine-foot) forward gondola, also known as the command gondola, slung underneath the hull. There they maintained the ship's altitude and course with two nautical-style steering wheels. The captain gave orders through an intercom-like speaker tube to mechanics in the engine gondolas as well as to crewmen manning the bombs and ballast or to lookouts and machine gunners atop the ship. Another pair of gondolas housed the massive diesel engines that powered the airship to speeds as high as 50 mph.

Zeppelins weren't simply balloons filled with gas; they had a rigid frame. The inside of the 650-foot-long hull was a gargantuan cage of duralumin girders and steel wires housing up to 19 hydrogen cells. Catwalks along the skeleton allowed 16 to 20 crew members to move through the ship, and a vertical ladder gave access to the outside through the top of the hull. Those not on duty could rest in hammocks slung along a gangway inside the hull between the forward and rear gondolas.

For the zeppelin crews, exhilaration and fear went hand in hand. Recalling a 1915 bombing run over London in a magazine article published 13 years later, Lieutenant Commander Joachim Breithaupt described flying high above the darkened city as he followed the windings of the Thames River to his target: "We watched the beams of the searchlights slashing into the sky like unsheathed swords looking for our airship…. The ship rocked when a round came close and shrapnel filled the sky. How could the enemy fail to hit the huge target that was my airship? One hit from the incendiary shells and they would go up in flames with no chance of escape. No zeppelin carried parachutes, for it had been decided every extra ounce of payload would be given to bombs."

While Breithaupt found the scene "indescribably beautiful—shrapnel bursting all around…and the flashes from the antiaircraft batteries below," he couldn't help remembering a sister zeppelin bursting into flames after being hit by enemy fire. As that ship fell to Earth, it was engulfed in a sickening glow for three agonizing minutes, its crew burning alive.

Nor was the destruction one-sided. Moments after he released his bombs, Breithaupt could see pools of fire and smoke on the ground below. The bombs had hit, but where? He knew aerial bombing was far from precise, and that many of his bombs

ZEPPELIN MUSEUM FRIEDRICHSHAFEN

A zeppelin's control gondola (above) served as the ship's bridge. Few crews survived crashes, but when the L33 came down over England in September 1916 (left), 22 crewmen were taken prisoner.

would likely miss their military or industrial targets, hitting homes and innocent people instead. In fact, he learned later, the bombs had fallen on London's theater district, where they started fires from shattered gas mains and killed a number of civilians.

When the zeppelins first appeared over English skies, the British countered by setting up listening posts and observers along the coast and on patrol ships to pick up the sound of airship engines. Anti-aircraft gun and searchlight batteries were placed around target cities. And fighter squadrons based in northern France made a series of daring raids on the few German airship bases they could reach in occupied Belgium.

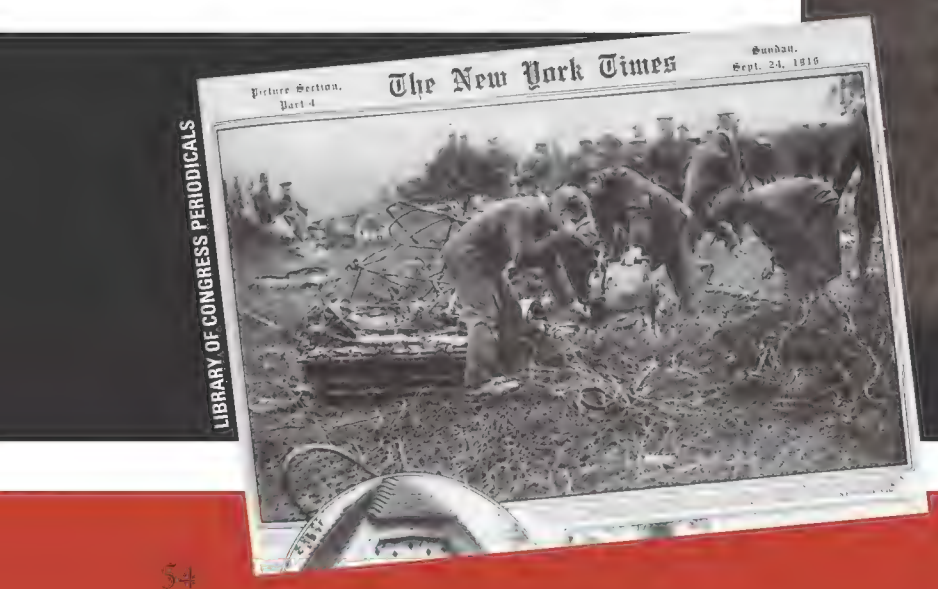
The zeppelins' Achilles' heel was the hydrogen that gave them lift, which could easily be set ablaze by incendiary shells or even bullets. Early in the war the airships generally flew too high for Allied airplanes to reach, but luck or resourcefulness sometimes helped the defenders. On June 17, 1915, Royal Flying Corps Sub-Lieutenant Reginald Warneford spotted LZ37—one of the few zeppelins owned by Germany's army instead of its navy—while flying his Morane-Saulnier L low near the Belgian coast. His account of what ensued is in the Imperial War Museum in London: "I arrived at close quarters with the zeppelin a few miles past Bruges, and the airship opened heavy machine gun fire, so I retreated to gain height and the airship turned and followed me. I came behind, but well above the zeppelin, and then slowed to descend on top. At 7,000 feet, I dropped my bombs, and, whilst releasing the last, there was an explosion which lifted my machine and turned it over. I went into a nose dive and regained control. Then I saw the zeppelin on the ground in flames." Warneford received the Victoria Cross for being the first pilot to down an enemy airship.

The British raced to improve both airplanes and guns. By early 1916 they had replaced their anti-aircraft batteries with more accurate French guns, and began deploying new fighters like the de Havilland DH2 and the Sopwith Camel with ceilings matching those of the airships. More important, pursuit aircraft began firing phosphorus incendiaries, called "flaming bullets," which caused so much grief to zeppelin crews that the Germans called them "the invention of the devil."

The improved defenses were tested in September, when the Germans attacked with an armada of 16 airships, the largest fleet ever sent against England. The early warning system along the coast gave Lieutenant William Leefe Robinson of the Royal Flying Corps time to scramble his new single-seat BE2c fighter. It took an hour to climb to the zeppelin's cruising altitude over London; the city was blacked out, the only illumination coming from searchlights. The higher Robinson climbed, the more numbing the cold in the open cockpit. For protection, the pilot had only his heavy flying suit and gloves.

At 12,000 feet over the Thames, Robinson spotted the distinctive shape of an airship caught in the beam of a searchlight. Before he could maneuver into range, the

NASM (SI NEG. #7A45051)



LIBRARY OF CONGRESS PERIODICALS

Left: British soldiers examine the wreckage of the L21, shot down over England in 1916. Accidents also claimed their share of airships: The L9 (above) burned up in its storage shed.

zeppelin saw him and disappeared into a cloud. Pushing his single-engine biplane to the limit, Robinson climbed to 14,000 feet and resumed a zigzag search pattern. At 1:30 a.m., his fuel tank nearly empty, Robinson began thinking about the dangerous night landing he faced on a fog-bound field, when the glow of explosions on the ground a few miles northeast caught his eye. It could mean only one thing: German bombs hitting their targets. The zeppelin that had dropped them couldn't be far away, so Robinson headed straight for the explosions.

By the time he was over the area, searchlights were combing the sky and he could see anti-aircraft shells bursting below him. There, its nose sticking out of a cloud, was the cigar-shaped gasbag of SL11.

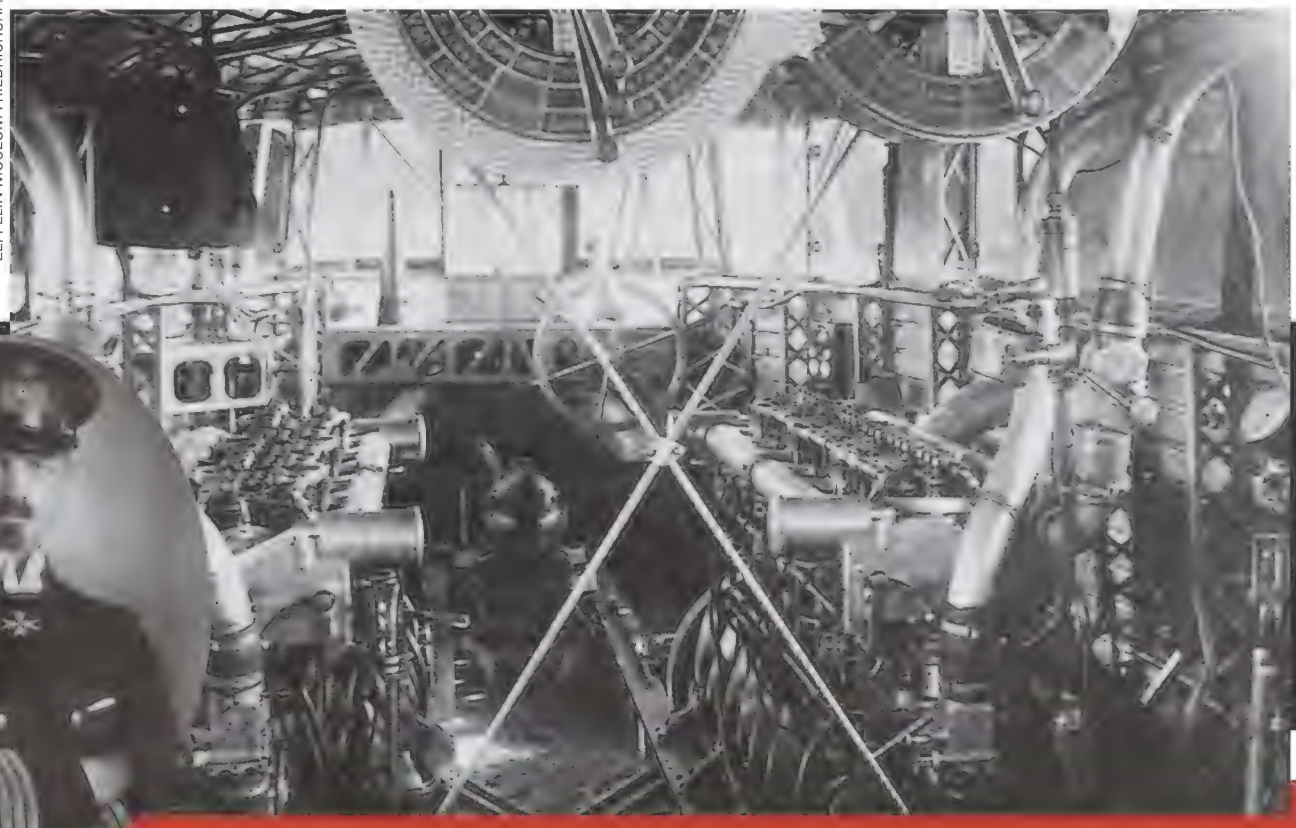
Robinson dove to gain speed. "I flew along about 800 feet below it," he reported on his return to base, "at an angle that blocked the view of the defenders, and fired one drum from my Lewis gun without effect. I moved to one side and gave it another drum, again with no effect." The zeppelin turned away and began climbing. The crew had seen Robinson, and machine gunners on the top of the airship and in the engine gondola soon began firing back. Tracers came his way, but they were off the mark. "By this time I was close, 500 feet or less below. I aimed underneath the rear and emptied the remaining drum."

The sky suddenly turned bright as day, and Robinson's airplane began to wobble and turn in a sea of incandescence. As he struggled to regain control, narrowly avoiding the fireball, the zeppelin's metal frame broke, and the pieces plummeted to earth, while men jumped from the airship to avoid being burned alive. Robinson was so elated by his victory he fired his Very pistol and dropped a parachute flare.

The downing of SL11 boosted British morale. The citizens held celebrations and rang church bells. For the German commanders, the loss prompted an all-out effort to counter airplanes that could now match their zeppelins' altitude. By August 1917, Strasser leapfrogged ahead of the British with redesigned "height climbers." The new airships were 700 feet long and 10 stories high, and due to lighter materials, a reduced bomb load, and even fewer amenities for the crew, they could reach more than 20,000 feet. For protection, the zeppelins carried 10 machine guns, four tons of bombs, and a new, more accurate bombsight.

The crews of the height climbers paid a heavy price for safety, however; the higher cruising altitudes were near the limit of human endurance. Oxygen deprivation caused dizziness and nausea in the gondolas, and in remote areas of the airship, men who lost consciousness risked death. Gloves were essential—those who touched the ultra-cold metal with their bare hands would leave their skin on it.

Even by World War I standards, zeppelin duty was a miserable assignment. Otto Mieth, watch officer aboard airship L48, wrote in his memoir that at 15,000 feet, "We shivered even in our heavy clothing and we breathed with such difficulty in spite of our oxygen flasks that several members of the crew became unconscious." As soon as the ship dropped its bombs on Harwich, 20 or



Peter Strasser (inset) headed the German navy's airship division. A zeppelin's engine compartment (below) hung from the gasbag.

ZEPPELIN MUSEUM FRIEDRICHSHAFEN (2)

30 searchlights converged on the intruder. Guns fired from the ground, and in an instant the ship was ablaze. "I heard the man next to me say, 'It's all over,' and I sprang to one of the side windows to jump out, the thought of being burned alive was so horrible," Mieth recalled.

"At that moment the ship's skeleton collapsed, the gondola swung over and I fell into a corner with others piling on top of me. I felt flames against my face and I wrapped my arms against my head, hoping the end would come quickly. That was the last I remember." When the ship's metal frame hit the ground it telescoped, breaking the fall. Mieth surmised afterward that the pile of comrades on top of him had shielded him from the flames. English soldiers heard his groans and pulled him from the wreckage—he was one of the very few men to survive the downing of a zeppelin.

Despite the losses, the raids continued. In October 1917 Strasser launched 11 height climbers in a massive attack. As they descended to a lower altitude on their return trip, half the zeppelins were destroyed by French and British fighters. Three months later five airships exploded in their hangars at Ahlhorn, Germany. Sabotage was suspected, but the cause was never established.

By this time, it was obvious even to their staunchest defenders that the airships were having little success. In late 1916 the German command had begun air assaults with twin-engine Gotha bombers, which had speed, range, and bomb loads that nearly matched the zeppelins'. In a single raid in June 1917, 23 Gothas did more damage than all the zeppelin raids combined.

The zeppelins still posed a threat, however, so the British decided to take the fight to their North Sea bases. The first target chosen was Tondern, near the Danish border in northern Germany. Tondern was beyond the range of Allied bombers launched from England, but the British solved the problem by taking the cruiser HMS *Furious* and replacing its superstructure with a deck, thus transforming the ship into an aircraft carrier.

Escorted by several smaller ships, *Furious* left Britain on July 18, 1918, carrying seven Sopwith Camels. At dawn the next day, the squadron led by Captain B.A. Smart took off for the German coast, 90 miles away. The attackers followed roads to the base, dove from 5,000 feet, and dropped their bombs on the huge hangar, destroying two zeppelins inside. The Tondern raid was the first successful attack ever launched from an aircraft carrier.

In August 1918, Strasser, ever the optimist, introduced yet another airship advancement. The L70 was a long-range, six-engine giant that could cross the Atlantic, drop an 8,000-pound load of bombs on New York City, and return to base without refueling. The Americans had recently joined the Allies, and Strasser hoped that such a raid would shock the Americans, knocking them out of the war. Before taking such a bold gamble, though, the commander decided to try out the L70 himself on a raid over England. He had already escaped death twice and won Germany's Iron Cross for bravery. The high command attempted to dissuade him, but Strasser would not be turned back.

Joined by four other airships, the L70 took off on August 5, just three months before the end of the war. To improve accuracy, Strasser decided to approach the target at low altitude, drop his bombs, then ascend to maximum height and be gone before the British could react. But the accompanying airships were picked up by coastal listening posts, and a swarm of British fighters were scrambled to meet them.

One of the swift, new de Havilland DH4 two-seaters, with Major Egbert Cadbury piloting and Captain R. J. Leckie in the gunner's seat, climbed unobserved and approached Strasser's ship. As Cadbury made his pass, Leckie fired bursts of incendiaries from close range. Flames spread along the hull, first

ZEPPELIN MUSEUM FRIEDRICHSHAFEN

LIBRARY OF CONGRESS PRINTS AND PHOTOGRAPHS DIVISION

Early in the war, the zeppelins were effective terror weapons (right). But even before a squadron of Allied airplanes got around to attacking their North Sea base at Tondern in 1918 (left), the airships' number was up.

toward the tail, then toward the bow. In less than a minute the airship, along with its crew, plunged to the ground in a mass of burning fabric and twisting metal. Strasser met his death in the last zeppelin raid of the war, and with him perished the German Naval Airship Division.

All in all, zeppelins fared badly in World War I. Of 123 airships that the German navy and the army flew during the war, 79 were destroyed by enemy action, weather, or accidents. Forty percent of zeppelin crew members, most of them volunteers, were killed in action—exceeding the percentage of losses suffered even by the U-boat service.

And for all the drama of the zeppelin raids, they did little to influence the outcome of the war. In 57 raids on England, the airships dropped an estimated 220 tons of bombs, causing $10 million in damage, injuring 1,500 people, and killing about 600 (of the nearly 10 million killed in the war). The raids did succeed in tying down more than 20,000 British soldiers and diverting guns and military airplanes from the front. They also caused blackouts that disrupted war plant production.

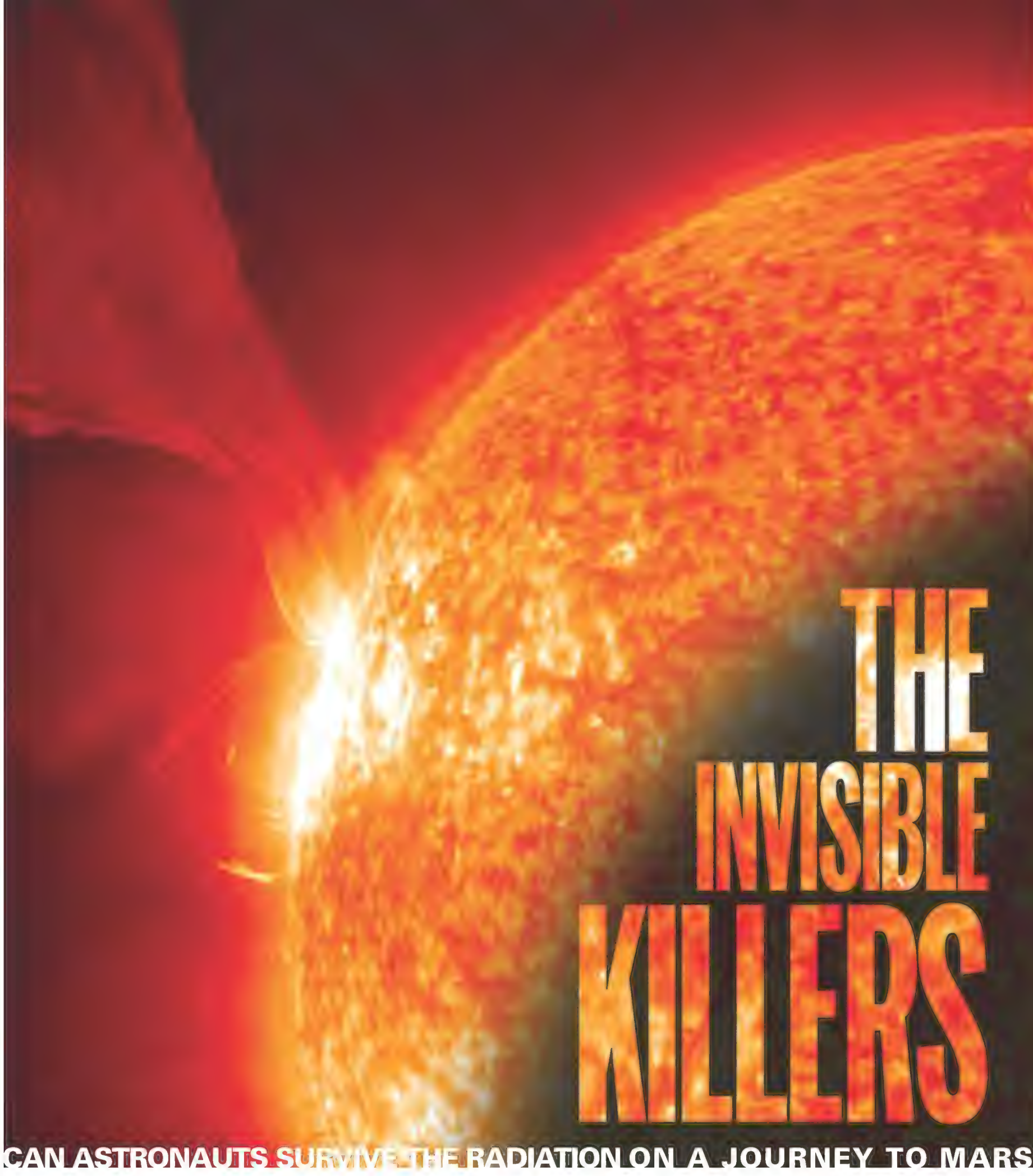
But the airships' greatest effect was probably on British morale, particularly early in the war. Even though the English came to realize the zeppelins were less of a threat than they had seemed, the raids had psychological consequences. "The scars of World War I air raids were never healed in the British mind," wrote Hanson Baldwin, a respected military analyst for the *New York Times*, half a century later. "Peoples' thoughts instinctively fly upwards," wrote British historian Liddell Hart. The zeppelin raids and lesser known attacks by Gotha bombers had made an indelible impression in the collective mind, according to Hart. "The tendency, whenever they think of war, is for the thought to be associated with the idea of being bombed from the air."

At the beginning of the next European war, Luftwaffe head Hermann Göring would play on these fears, boastfully threatening in 1939, "Once again as the German zeppelins did 25 years ago, German squadrons will unleash air raid alarms over London. The German Air Force will strike at Britain with an onslaught such as has never been known in the history of the world."

So Strasser's vision survived, even if the technology didn't. In the 1920s and 1930s, zeppelins were used only as passenger ships, the *Graf Zeppelin* and *Hindenburg* being among the most famous. But the goal of demoralizing an enemy from the air remained the same—whether from zeppelins or buzz-bombs or B-29s—as the citizens of London, Dresden, Tokyo, and Hiroshima would find out all too soon.

NASM (SI NEG. #00103298)

Near the end of the war, Peter Strasser unveiled his long-distance "height climbers," the most advanced of which were to cross the Atlantic and bomb New York. But the L53 (left) suffered the same fate as other, lesser zeppelins: In 1918 it was shot down by British aircraft; 19 died, none survived.



NASA

THE INVISIBLE KILLERS

CAN ASTRONAUTS SURVIVE THE RADIATION ON A JOURNEY TO MARS?

BY JOHN F. ROSS

At 5:54 a.m. on Tuesday, October 28, 2003, a giant flare exploded on the surface of the sun, sending a cloud of hot gas and charged particles hurtling toward Earth at nearly five million miles per hour. While managers of satellites and electric utilities braced for disruptions in power grids and satellite and radio communications, technicians at NASA's Johnson Space Center in Houston hurriedly radioed astronaut Mike Foale and cosmonaut Alexander Kaleri, who were orbiting Earth in the International Space Station.

To protect them from the blast of charged particles, mission control had the pair climb into the back of the station's massive Zvezda module (which contains the sleeping quarters, galley, and lavatory), where the shielding is thickest. During five 20-minute peak exposures that day, the team sought shelter.

NASA officials later calculated that if the two had not retreated to Zvezda,

their exposure would have been minimal: In 20 minutes they would have been exposed to the amount of radiation they usually received in the station over a period of 24 hours. Yet NASA also acknowledges that the two onboard instruments designed to measure astronaut exposure to radiation were malfunctioning, so the agency does not know how much radiation the astronauts were exposed to.

And what would have happened if, during one of those times of peak exposure, Foale and Kaleri had been spacewalking? Or what if they had been on the moon, or on Mars?

After close to half a century of manned flight, we still know very little about the dangers astronauts face from radiation in space. Only the 27 Apollo astronauts who orbited or landed on the moon have gone beyond Earth's magnetic field—which protects us from most space radiation—and then only for a short time. We do know that on the Apollo 14 moon mission, for example, between takeoff and landing, the three astronauts each received about 1,140 millirem of radiation—a little more than three times the amount people are exposed to on Earth during the same period.

Last January, President George W. Bush announced plans for much longer space missions, including lengthy manned missions to the moon as early as 2015, followed by flights to land a human on Mars. Bill Anders, an astronaut on Apollo 8 and a retired nuclear engineer, believes that Bush's vision of future manned exploration "greatly underestimates or ignores the risk of high-energy radiation." He points out that astronauts can be endangered by a number of sources of radiation: "What's the point of building a nuclear rocket ship—the only way we're going to get to Mars—if the astronauts get singed on the way there?"

But Robert Zubrin, independent mission planner and president of the Mars Society, scoffs at concerns over radiation risks. In the trade publication *Space News*, Zubrin wrote an article entitled "The Great Radiation Hoax," in which he declared: "Mars mission cosmic radiation doses [are] well within the range of existing spaceflight experience."

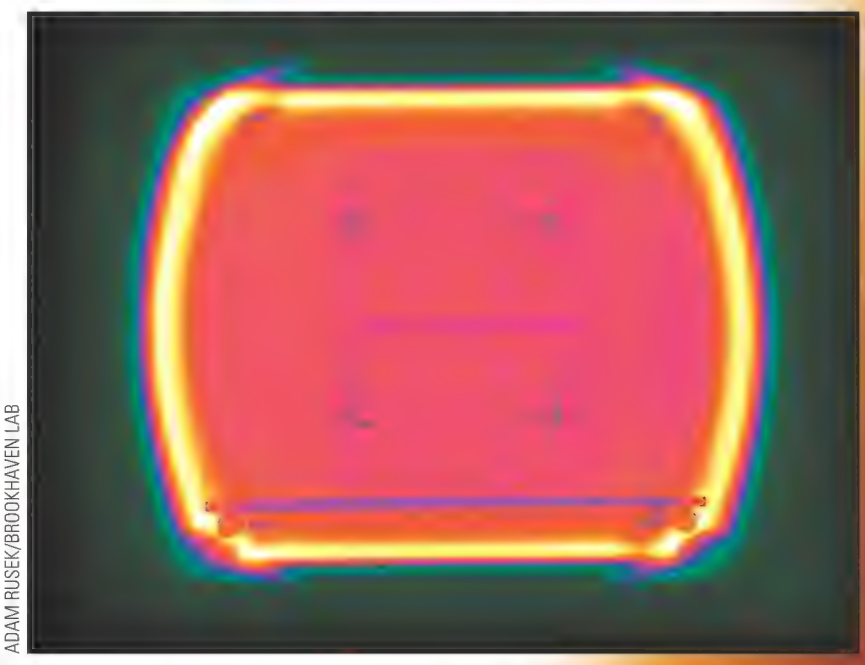
Who's right? Scientists don't yet know. From the World War II atomic bomb detonations in Japan and the 1986 accident at the Chernobyl nuclear reactor near Kiev, Russia, we know the effects of brief but intense pulses of radiation: nausea, immune system shutdown, central nervous system damage, and death within minutes or hours. And scientists have documented the effects of the constant, naturally occurring radiation found on Earth—the ultraviolet rays from the sun that cause melanoma, for example. But the forms of radiation found in space are different creatures entirely. While data from space probes and sophisticated computer modeling provide a good idea of how much and what kind of radiation normally exists between here and Mars, "we just don't know how the human body will react to it," says Frank Cucinotta of NASA's Space Radiation Health Project at the Johnson Space Center. Walter Schimmerling, NASA program scientist for space radiation research, elaborates: "We don't know if a three-year mission to Mars is equivalent to an astronaut sitting at home for the same period smoking cigarettes, or the equivalent of smoking for 30 years and living in a coal mine."

Cucinotta and Schimmerling are at the forefront of a community of researchers working on what may be the most complex example of risk analysis ever undertaken. The study of space radiation is forging collaborations between researchers in widely different disciplines, from spacecraft engineering to solar physics to molecular biology. But so far, the results have not produced a detailed picture of how space radiation would affect human beings over long periods. And until that information is available, "we just can't send [astronauts] into space and see what happens," says Cucinotta. "Until we better understand the risks, NASA won't send astronauts on long-duration spaceflights."

The Alpha Beta Gammas

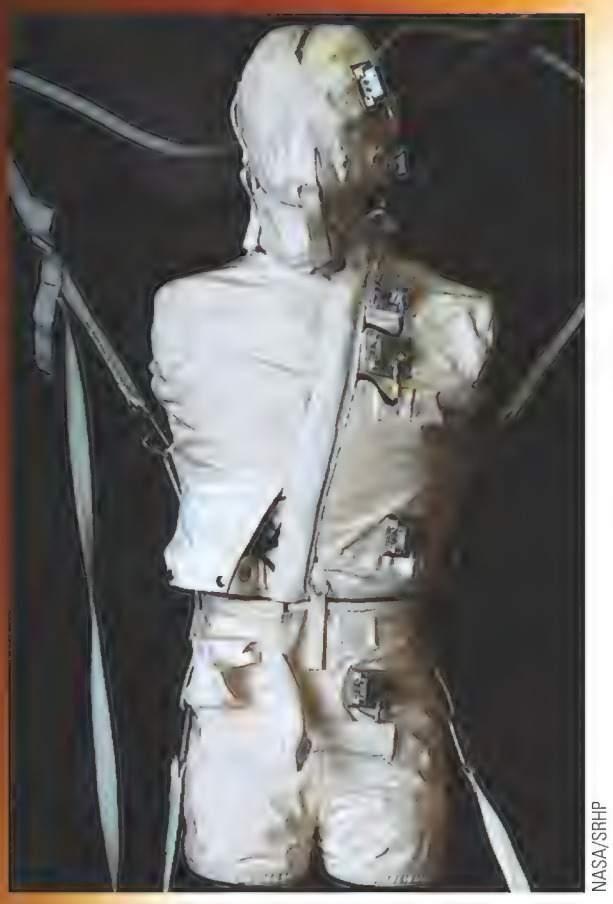
Solar storms, largely unpredictable, are not the only radiation danger in space. Far outside our galaxy, violent events such as the explosions of stars produce particles called cosmic rays. The atoms in cosmic rays are charged, or ionized: Because they have either lost or gained an electron, they carry a negative or positive charge. Heated to very high energies, these particles race through space at extraordinary speeds.

Cosmic rays can be made up of any element on the periodic table up to iron (the table lists elements by increasing atomic weight). Cosmic rays made up of heavy elements are particularly dangerous. A charged particle of iron, for example, slams into atoms in a cell and sends them careening like a cue ball hitting the rack. These newly energized particles hit others, setting off a cascade of destruction. Lead, for instance, while highly effective at shielding bodies against X-rays in the dentist's chair, is such a heavy element that atoms set loose from it could prove lethal to astronauts using it for shielding.



ADAM RUSEK/BROOKHAVEN LAB

Mission planners worry about astronauts' exposure to various solar outbursts (opposite), which can't always be predicted. To simulate damage caused by space radiation, scientists at NASA's Space Radiation Laboratory place animals and cell cultures on a platform (right) and irradiate them with a heavy-ion beam.



NASA/SRHP

Endowed with actual bone and simulated soft tissue, the Phantom was strapped to the space station in 2001. Its 350 sensors gave scientists an idea of how space radiation may affect different organs.

Other forms of radiation populate deep space and may pose a danger to astronauts: X-rays, alpha-rays, beta-particles, gamma-rays, and neutrons. All contain excess energy and, in an attempt to stabilize themselves, throw off mass or energy. The high energy of these particles enables them not only to travel at or near light speed but also to penetrate shields and burrow deep into human tissue.

Sim City

In the space between here and Mars, the distribution of cosmic rays is not dense enough to induce acute radiation sickness. But what if the exposure consisted of a low, steady level of ionizing radiation over a two- or three-year mission in deep space? Would that cause subtler health problems? Scientists estimate that an astronaut in a conventional spacecraft on a 900-day Mars mission might encounter as much as 130,000 millirem—a dose equivalent to what you'd be exposed to living 370 years on Earth.

To help build a database that relates levels of radiation exposure with adverse effects, NASA runs the Space Radiation Laboratory at the Department of Energy's Brookhaven National Laboratory in New York. Adam Rusek oversees the daily operations of the new $34 million facility, which is the only one in the United States devoted exclusively to studying the effects of radiation on living creatures.

The NSRL is housed in an unimpressive low gray building in the woodlands of central Long Island. Here, Rusek and his team of physicists operate a particle accelerator that can replicate deep space's highly charged subatomic particles, accelerate them to nearly the speed of light, and then slam them into vials of tissue and cells, laboratory animals, and various shielding materials.

Rusek also runs a "summer camp" for biologists to learn the rudiments of particle physics. Sitting in the NSRL's cramped kitchen, which serves as an informal command center, Rusek comments with a wry grin: "You'd be surprised how many biologists don't know what a Gaussian wave is." (It's a phenomenon of quantum physics.)

To simulate particles found in space, Rusek and his colleagues begin with ordinary materials, such as iron and carbon. They energize the particles by heating them until they are dangerously unstable. During experiments, Rusek mans a computer near the large steel door that marks the opening to the accelerator. From here he operates a Sony webcam that provides views of the 400-square-foot room where the speeding particles end up. Because of the danger involved in the experiments, opening the door can take up to five minutes, requiring an iris scan (to confirm the researchers' identities), a sign-off from an operator watching on a video camera in another building, and a series of key insertions into a bank of instruments.

Once the door opens, the white-painted cinderblock hallway cuts left, then right, then left again, a precaution against errant particles escaping. The hallway ends at the chamber, which contains a 30-foot track of parallel stainless steel bars; the bars follow the path of the particles and disappear into a hatch in the wall. As the particles travel down the track toward this room, a series of powerful magnets attached to the bars accelerates them and focuses their path.

Marcelo Vasquez, an energetic Argentinian-born biologist and physician, is chief of medical research at NSRL. Presently, he is using mice to look at the effect of ionizing radiation on cognitive function. Vasquez and his colleagues built a three- by three-foot plexiglass pool with a small platform within. They trained mice to swim to the platform and climb on it. After the mice grew proficient at the task, the scientists recorded their times.

Vasquez then strapped three trained mice at a time to a small block of Lucite and irradiated them in the accelerator chamber. Next, he put them back into the water and found that it took the mice longer to find the platform than it had before. The radiation exposure, says Vasquez, caused the animals to lose brain cells quickly. He does acknowledge, however, that in his experiments he administers high doses of radiation, and one can't necessarily extrapolate directly from the mouse results to what humans will experience.

Vasquez brings up on a computer screen a series of slides showing mouse brain cells exposed to increasing levels of ionizing radiation. The network of axons and dendrites, the structures that enable cells to communicate with one another, first appears as a field densely packed with shapes and fibers. By slide four, the picture is sparsely filled: Cell nuclei look like they have exploded, their contents spread randomly. The image is reminiscent of a block in World War II-era Dresden after a bombing run. The radiation, explains Vasquez, doesn't kill all the cells, but it severely disrupts the flow of signals. Vasquez's colleague, Derek Lowenstein, chairman of Brookhaven's collider accelerator program, has given voice to deep fears among scientists by asking: "Will astronauts come back blithering idiots or not?"

Vasquez is also concerned about other factors that may exacerbate radiation damage. "We're testing mice here on Earth in a comfortable 1 G envi-

ronment," he says. Put people in space, and "their physiology will be stressed and that can't help their response to radiation damage."

Another NSRL researcher, Betsy Sutherland, is studying the cellular destruction wrought by ionizing radiation. If an ionizing particle hits DNA in a cell's nucleus, it can cut one or both strands of the double helix like a chainsaw ripping through a tree branch. Evolution has ensured that organisms have mechanisms to repair insults to genes, which occur regularly from such sources as the sun's ultraviolet rays and natural toxins contained in food.

human torso, Phantom, which was attached to the outside of the International Space Station in 2001. The dummy contained actual human bone, plastic material simulating soft tissue, lighter material representing lung tissue, and a covering of Nomex to simulate skin. Phantom was also enclosed in material simulating a spacesuit. About 350 radiation meters were placed throughout the torso, including the sites of critical and susceptible organs, such as the brain, heart, thyroid glands, and kidneys. The results from Phantom's exposure turned out to be similar to those predicted by NASA models. The

A series of slides shows mouse brain cells exposed to increasing levels of radiation. The first slide looks like a field densely packed with shapes and fibers. By slide four, which reflects high doses of radiation, the picture is sparsely filled. Cell nuclei look like they have exploded, their contents spread randomly. The image is reminiscent of a block of WWII-era Dresden after a bombing run.

Proteins move quickly to reattach broken strands and splice in new sections of DNA if necessary. Cells too badly damaged to be fixed get tagged by the p53 gene, which orders the cell's death. From the organism's perspective, it's better that a cell die than become fixed incorrectly: Cells with mutations could lead to cancer or defects that can be passed on to the next generation. Sutherland says that ionizing radiation appears to impede the p53 gene from doing its job.

Sutherland and other biologists have noted other disturbing effects of radiation on cells, such as "the bystander effect," in which damage to one part of DNA causes damage to other DNA segments far away.

The researchers at the NSRL are well aware of the limitations of the work here. For example, they can shoot only one type of heavy-ion radiation at a time; in space, astronauts will be exposed to a barrage of many kinds. It is also difficult for researchers to design a lab simulation that shows how space radiation is distributed among various parts of the human body. The European Space Agency built a simulated

experiment also showed that more than 80 percent of the radiation that hit the dummy came from cosmic rays; protons, on the other hand, were weakened by passing through the spacecraft and Phantom's skin.

NASA is also preparing to make measurements directly in space. The agency is now accepting proposals for instruments to go aboard the Lunar Reconnaissance Orbiter, an unmanned probe scheduled to launch in the fall of 2008. The first objective of the mission is the "characterization of the lunar radiation environment, biological impacts, and potential mitigation by determining the global radiation environment, investigating shielding capabilities, and validating other deep space radiation prototype hardware and software."

SPF 15,000,000,000

The best solution to the problem of space radiation would be to prevent exposure in the first place. Ideally, during a solar flare, astronauts could protect themselves by positioning their spacecraft so that a nearby planet, moon, or other celestial object serves

as a shield, but that option is not available for a trip to Earth's next-door neighbors, the moon and Mars. Even in future explorations of the outer solar system, the unpredictability of solar weather may make that option unrealistic. While the 11-year solar cycle is well documented, the occurrence of solar flares and the related coronal mass ejections have so far defied prediction. It's especially difficult to monitor the weather on the side of the sun not facing Earth.

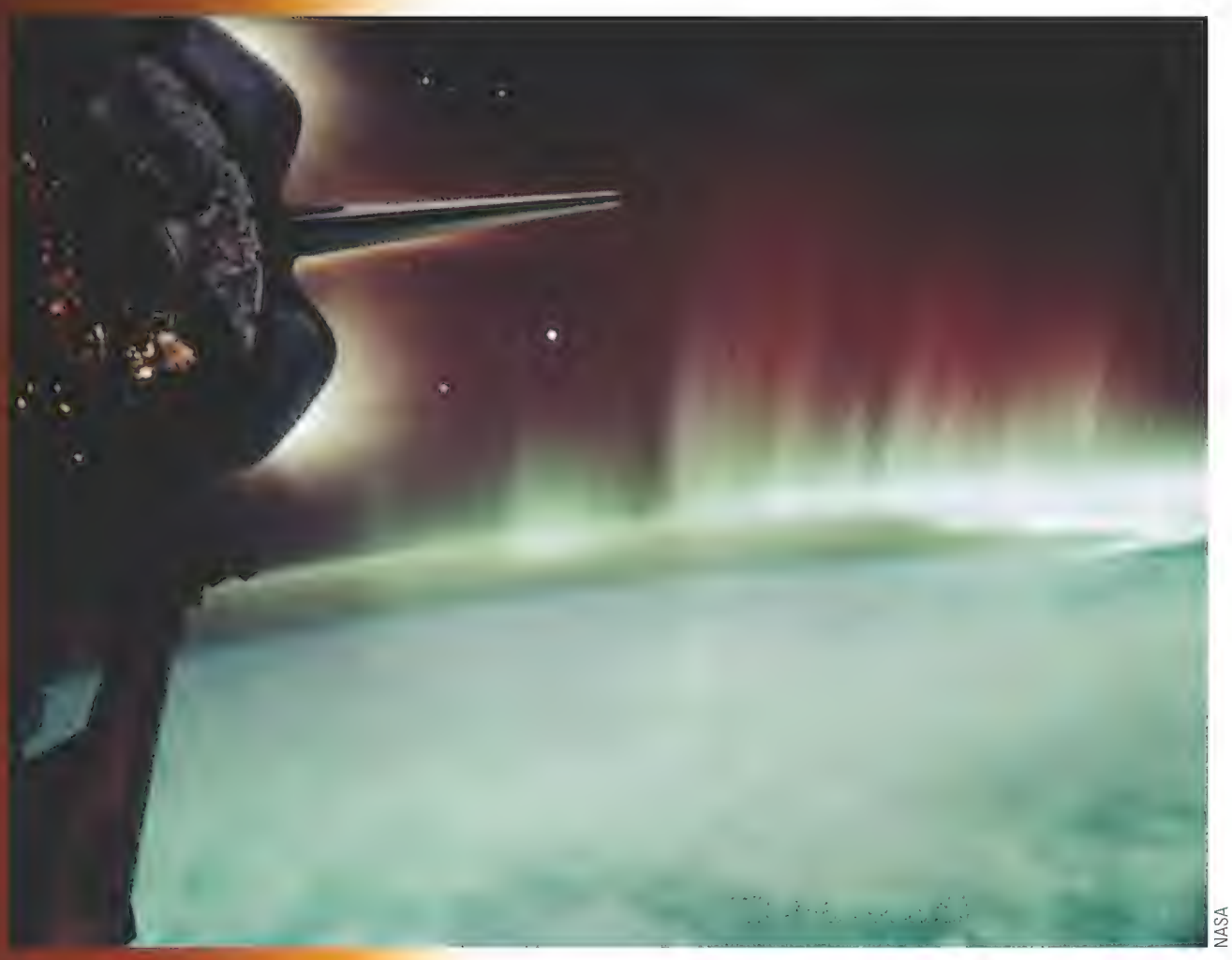
Another solution would be to equip spacecraft with enough radiation-proof shielding. But while increasing the thickness of shielding material would block more radiation, the added thickness would also provide *more* atoms for an incoming particle to hit, and those impacts could set off others, resulting in a domino effect that ultimately damages human tissue. The net effect of increasing the thickness of conventional shielding is negative until you scale the material up to the equivalent of a substantial concrete bunker, which, of course, is too heavy to send into space.

Engineers are evaluating non-conventional forms of shielding and construction materials. The best shield, says Brookhaven's Lowenstein, is liquid hydrogen, but its volatility makes it dangerous. Although less effective, water would also serve as a good shield. Other promising materials include hydrogen-rich plastics, such as polyethylene, the material used to make garbage bags. Engineers at NASA's Marshall Space Flight Center in Alabama have developed a reinforced polyethylene that is 10 times stronger than a comparably thick piece of aluminum, although price may prove a problem in its deployment. Creating an electromagnetic field around a spacecraft or the development of other kinds of "active" shielding is expensive and brings with it concerns about the technology affecting the health of the crew members. But Larry Young, a space medicine expert at the Massachusetts Institute of Technology in Cambridge, says that future shielding strategies may include the use of superconducting magnetic technology.

Risky, Riskier, Riskiest

The U.S. Occupational Safety and Health Administration treats astronauts as radiation workers. Therefore, the level of radiation that an astronaut can be exposed to over his or her career falls under the guidance of the National Council on Radiation Protection and Measurements, a not-for-profit corporation created by Congress in 1964 to collect information and develop guidelines about radiation exposure for workers of all kinds. Today, the law limits the amount of radiation that nuclear workers, including astronauts, receive to 5,000 millirem over the course of their careers.

The limits have already had effects on astronauts, who are required to wear radiation-monitoring badges on missions—silicon dosimeters on aluminum. In 2002, astronaut Don Thomas, who had flown on four prior missions, for



NASA

The shuttle's vertical stabilizer juts into a landscape that seems to buzz with radioactivity: Earth, fringed with the Southern Lights. Such auroras result when high-energy particles from the solar wind are trapped in Earth's magnetic field. This field protects Earth-bound humans from most space radiation.

a total of 1,040 hours, was pulled off the ISS Expedition Six crew because NASA decided that the long-duration mission would put him over the lifetime radiation exposure limit. NASA's Frank Cucinotta monitors astronauts and their badges, and often has to compare the badges of all the astronauts on a shuttle mission to see if anyone's badge is registering particularly low levels. "They sometimes hide their badges" in a shielded area of the shuttle, he says, "because they don't want to go over their limit."

Even if every astronaut wore his or her badge at all times, the risk/benefit calculation is complicated by the fact that not all astronauts are created equal. Early evidence suggests that the presence of a certain gene indicates an increased susceptibility to the negative effects of radiation. In addition, radiation exposure affects older people faster and more severely than it does the young. And, because of their susceptibility to breast, uterine, ovarian, and cervical cancers, women are prone to a greater variety of cancers than men.

How should we draw the line to distinguish an acceptable risk from an unacceptable one? For cancer, the number is currently based on the 1989 "NCRP Report Number 98," which recommends that cancer mortality for the population of workers in question should be no more than three percent above the average cancer mortality in the United States. The "three percent above" guideline is based on the additional mortality facing Americans in the most physically hazardous occupations, such as mining. Because a 40-year-old American man has a 20 percent chance of developing a fatal cancer in his lifetime, the NCRP added 20 percent and three percent to determine that 23 percent is the acceptable level of cancer risk that an astronaut can assume. In 2000, the NCRP revisited its recommendations and reaffirmed this basic risk calculation. But, based on follow-up studies of the survivors of the two atomic bombs dropped in Japan in 1945, the NCRP cut the maximum acceptable radiation doses significantly, by nearly half or more.

And that's just for cancer risks. The challenge facing researchers, says Brookhaven's Vasquez, "is integrating all the various risk factors for radiation into a model." For example, says Cucinotta, astronauts develop cataracts much more frequently than average.

Based on a 2001 study of cancer patients undergoing radiation therapy and epidemiological studies of the atomic bomb survivors, Cucinotta has calculated that the added cancer risk of a 1,000-day Mars mission in an aluminum spacecraft, which would shield half the cosmic rays encountered, falls between one and 19 percent. A one percent increase is a risk most people would find acceptable. But taking the highest risk number and adding that to an astronaut's normal incidence of getting cancer (20 percent) results in a whopping cancer risk of 39 percent.

Cucinotta's best guess estimate is that without extra hydrogen shielding, Mars missions of 660 and 1,000 days would push 40-year-old astronauts over the NCRP risk thresholds.

Frank Cucinotta has calculated that the added cancer risk for an astronaut on a 1,000-day Mars mission in an aluminum spacecraft, which would shield half of the cosmic rays encountered, falls between one and 19 percent.

The Blueberry Fix

As they build up their database, scientists may determine that astronauts' radiation exposure should be reduced significantly. The low-tech fix would be to simply limit each astronaut to fewer trips. But then more astronauts will need to be trained, and space agencies will need bigger budgets.

Another approach is to pull astronauts from flight duty when they show signs of an imminent health problem. Late last year, NASA awarded $9.7 million to Colorado State University in Fort Collins to study how acute myelogenous leukemia develops. AML, a cancer of the bone marrow, is commonly associated with exposure to radiation. The CSU scientists will look for clues that cells are going to turn malignant. NASA hopes that the research will help physicians analyze tissue samples to determine when an astronaut is in danger of developing cancer.

Astronauts will also carry agents that will help their radiation-damaged cells repair themselves. "Over time, the DNA repair process doesn't catch everything and mistakes can begin to add up," says James Joseph, a biologist at the Human Nutritional Research Center on Aging at Tufts University in Massachusetts. He and his colleagues have discovered that the antioxidants in certain foods, particularly blueberries and strawberries, can help aid damaged cells repair themselves correctly. And Ann Kennedy of the University of Pennsylvania School of Medicine and her colleagues have discovered that selenomethionine, a compound of the element selenium and an amino acid, enhances the ability of DNA in irradiated mouse cells to repair itself.

And, while the scenario remains science fiction for now, future astronauts could one day travel into space with stem cells—undifferentiated cells ready to change into any kind of specialized cell—and use them to repair damage to their bodies.

So many of these proposed solutions are speculative, or unrealistic, at least with today's technologies. Could radiation ultimately prove to be a showstopper? No matter what data the scientists come up with, not everyone involved in spaceflight will interpret the risks the same way. Says astronaut Tom Jones, a veteran of four shuttle missions, "Telling me that I may get cancer 30 years from now if I go to Mars doesn't seem like a big deal, because sitting atop a rocket and going there is itself so risky." But even the astronauts most gung-ho to push on to Mars acknowledge that the potentially severe effects of radiation are something to be worried about.

SPEED

HOW THE FASTEST BOMBER FADED AT THE FINISH.

BY DALE SMITH

Bullet in the blue sky: The B-58 Hustler lived fast and died young.

THE DESIGN OF U.S. FRONTLINE FIGHTERS AND bombers—the F-117, F-22, and B-2—is primarily based on a simple defensive strategy: If they can't see you, they can't shoot at you. But way back when radar was young and stealth technology was a far-off dream, the Air Force bet on a different strategy: They may see you, but they sure won't catch you. In the 1960s, the Air Force relied on speed to penetrate enemy airspace, and the airplanes built to be uncatchable were as radical in their time as the first stealth aircraft were in the 1980s and '90s. One of them, the Convair B-58 Hustler, looks radical even today.

With its long, slender fuselage, dramatically swept delta wing, and four big engines, the B-58 looked fast even when it was on the ground. It was one of the first aircraft to take advantage of the knowledge that the way to overcome drag in supersonic flight is to sweep the wings at such an angle that the aircraft flies within the Mach cone, a three-dimensional bow wave formed around a body moving through the air at supersonic speed. When the wings are within that cone, the airflow over them remains subsonic. So successful were the Convair aerodynamicists at managing supersonic flight that on October 15, 1959, the first production Hustler flew faster than Mach 2 for more than an hour. Refueling once, the aircraft traveled 1,680 miles in 80 minutes.

The world's first supersonic bomber inherited its delta wing from earlier Convair projects: The XF-92A was the world's first delta wing aircraft and the foundation for Convair's F-102, the world's first supersonic interceptor.

Early in the development phase, engineers on the XF-92A discovered during wind tunnel tests that the highly swept, narrow-chord wing was very unstable. A Vultee aerodynamicist, Ralph Shick, suggested a solution to Adolph Burstein, chief technologist, and Frank Davis, test pilot and head of Aero and Flight Test: "Why don't we just fill in the area between the two wing tips?" Shick hypothesized that changing to a single, triangle-shaped wing would generate more stability and control. He was right.

Although the delta wing concept first appeared during World War II in Germany, Bill Chana, a former XF-92A flight test engineer, says the XF-92A's design was a Convair original. "A lot of people think Burstein and Shick got the delta idea from the Germans," says Chana. "That's just not true. Their delta wing configuration for the Convair interceptor was their own thinking."

By early 1953, Convair had begun work on the XB-58 and XBR-58. They relied on their findings from the XF-92A program (retired in 1953) and 10,000 design configurations they

explored to advise the Air Force, under a general study, of the designs that would promise the best performance for supersonic bombers.

"The original mission profile for the B-58 was to cruise to the target area at .91 Mach, then dash at Mach 2-plus above 50,000 feet for approximately 500 miles," remembers Harold "Hal" Confer, the second Strategic Air Command pilot to be certified as operational in the B-58. "We'd drop the pod containing the nuclear weapon and return to home base at .91 Mach cruise. We could outrun and out-distance all of our fighters of that era, which certainly brought a smile to the face of this old bomber pilot."

"When the B-58 was designed, [the Russians] hadn't really perfected a surface-to-air-missile system and didn't have a high-altitude supersonic fighter yet," says Ben Baddley, a B-58 navigator/bombardier. "The B-58 was created to take advantage of that situation."

According to Convair's company newspaper, *Convariety*, the B-58 got its name, the "Hustler," when the new aircraft's performance was described to E. Stanton Brown, an engineering administrative supervisor. His response was "Sounds like it'll really be a hustler...." The name stuck. At first, it was just the name used by the engineers working on the Convair program, but the Air Force eventually (and reluctantly) made it the aircraft's official name.

One of the most significant technological advances was Convair's designing the fuselage with the use of area rule, which the company first used on the F-102 supersonic interceptor. Developed by Richard T. Whitcomb of the National Advisory Committee for Aeronautics' Langley Field Laboratory, the area rule resulted in a "Coke bottle" shape, greatly reducing aerodynamic drag along the fuselage and wing section at both transonic and supersonic speeds—the lower the drag, the higher the speed. It took Convair several tries and the help of NACA aerodynamicist R.T. Jones to design the fuselage.

The B-58's shapely fuselage housed a unique crew configuration. Each of the three crew members—a pilot, a navigator/bombardier, and a defensive systems operator—was housed in his own compartment. Separated by banks of equipment, the crew members had no physical contact with one another, although the crew could pass notes via a string-and-pulley system that ran along the cabin wall.

The B-58's bullet-like speed was both a blessing and a curse to its three-man crew. The speed made the aircraft nearly impossible to pursue. But should a catastrophic airframe or system failure occur, a standard ejection at Mach 2 would be unsurvivable. Despite this fact, the first B-58s had only standard, rocket-propelled ejection seats, and the use of them resulted in several deaths. In 1962, common sense finally prevailed, and the B-58s were retrofitted with an encapsulated ejection system (see illustration, p. 68).

While the escape pod was the only way to attempt an ejection at Mach 2, some crew members were not sold on the capsule's value. "Our crew was dispatched to pick up the first production aircraft with the capsules installed," recalls Howard Bialas, a B-58 defensive systems operator from 1958 to 1965, the first person to accrue 1,000 hours in the bomber. He was also a member of a crew who set three

OPPOSITE: NASM (SI NEG. #92-6564)

HE REAK

By 1970, the entire fleet was left to roast at Davis-Monthan Air Force Base in Arizona.

STEVE WILLIAMS

"The purpose of the B-58 was to try to change the dynamics of any potential engagement with the Soviets," says Richard P. Hallion, former Air Force historian. "The thinking was that a supersonic bomber would compress the Soviet's response time of their interceptors, tracking and search radars, and even the time it would take for surface-to-air missiles to be properly aimed."

The B-58, however, was not the unanimous choice within the leadership of the Strategic Air Command to fill that role. SAC commander Curtis LeMay wanted to start over with a different design. The project limped along with the support of the Air Research and Development Command.

"The B-58 is a major advance, considering that we are attempting to more than double our speed capabilities. For that reason, I believe that it has a place in the Air Force inventory," argued Major General Albert Boyd in a 1951 progress report to Lieutenant General Thomas Power, then ARDC commander. "Since we are attempting such a major advance, there is very naturally a high degree of risk."

NASM (SI NEG. #6569)

"THERE IS VERY NATURALLY A HIGH DEGREE OF RISK.... WE DO NOT KNOW ALL THE ANSWERS AND WILL NOT UNTIL WE HAVE FLOWN SUCH AN AIRCRAFT. THUS, WE MUST ACCEPT SUCH A RISK SOONER OR LATER IF WE ARE IN FACT EVER GOING TO ACHIEVE A TRULY SUPERSONIC BOMBER."

world speed records in the B-58 in 1961. "We were more than hesitant to crawl into it. There was no reason to use it at Mach 2. If a structural failure occurred, you would never be able to pull the handles. And if deceleration [from an engine failure] was necessary, just hang on, [you] would be subsonic in a few seconds. Deceleration was much more rapid than acceleration. We didn't sweat Mach 2 before we got the capsules, so why after?"

Like toe shoes on a grizzly, the Hustler's 22-inch wheels (inflated to 240 psi) were too delicate for the weight and heat to which they were subjected, resulting in frequent blowouts. At right: The B-58's ominous, multi-purpose fuel and munitions pod.

NASM 1A23648

Although the escape capsule was credited with saving a number of crew members, Bob Norton, who flew the B-58 out of Bunker Hill Air Force Base in Indiana, remembers one instance in which it contributed to a fatal crash. "One of our guys was flying in western Texas and some hail blew the windshield out. He encapsulated himself—you could still fly the airplane with the capsule closed but you could not control the throttles. Anyway, when the windshield blew, he pulled the throttles to idle before he closed the capsule. The trouble was, he couldn't get [the capsule] open again when the hail stopped," he says. "With the throttles pulled back, he was going down, so he told the other crew members to bail out. Unfortunately, the navigator's parachute didn't deploy and he was killed. After that they installed a cable so the pilot could quickly pull the pod open in flight."

The B-58's wings had to have a very high strength-to-weight ratio to handle high speeds at low altitudes. "That thin wing and the delta sweep made going through the sound barrier like slicing a piece of cheese," says Chana. "It would penetrate the sound barrier without any shaking or anything."

Convair's engineers used a new honeycomb sandwich design to achieve the high strength and low weight they needed. Sections of fiberglass honeycomb were sandwiched between aluminum panels and then bonded to the wing's

frame using temperature-resistant adhesives. Molding the honeycomb panels was a painstaking process, resulting in structures that were rigid and resilient—necessary traits for a wet wing holding 65,000 pounds of fuel.

The Hustler's external pod was an integral part of its aerodynamic design. The pod comprised interchangeable compartments for weaponry, fuel, and equipment, which could be deployed separately or together. During the design phase, the configuration proved to have disadvantages as well—every time designers wanted to make a change to the airframe, they had to adjust the pod's configuration too.

HISTORY OFFICE EDWARDS AFB

The only bomber crew to win the Thompson Trophy pre-flights the Hustler (left). The first few B-58 crews trained in Convair's TF-102A (below) until 1960, when the TB-58A trainer entered service.

Despite its sophisticated hardware, the B-58's limited range continued to hinder its acceptance into SAC's arsenal, and the bomber was almost cancelled many times during development. Although progress with aerial refueling greatly extended the bomber's range, SAC's commanders continually debated the overall value of an airplane so dependent on refueling to complete its mission.

Major General John McConnell, SAC's Director of Plans, declared that his command was interested in the development of the B-58 as a future weapon system but not for the SAC inventory. McConnell called the B-58 a "short-legged plane," adding that "as long as Russia (and not Canada) remained the enemy, range was important." The B-58's range limitations would haunt it throughout its operational life.

"We do not know all the answers and will not until we have flown such an aircraft," wrote Major General Boyd in defense of the B-58 program. "Thus, we must accept such a risk sooner or later if we are in fact ever going to achieve a truly supersonic bomber." The people accepting the risk were the test pilots and bomber crews who tried to tame the Hustler.

The B-58 Hustler made its first flight on November 11, 1956, from the Convair facility at Carswell Air Force Base in Fort Worth, Texas. The initial flight lasted 38 minutes and was made without the pod and without the use of afterburners. It was also the first time the Hustler was introduced to the public at large. During its development, little information had been leaked about the aircraft's technological advances. About 30,000 people watched the bomber lift off for its flight that day. The first supersonic flight took place the following month.

While it got off to a smooth enough start, the B-58's test and development program was a rocky one: Five of the first 20 test aircraft were lost to causes ranging from structural stress to "unexplained." Even proponents of the program believed the accident rate was due to rushing the airplane into production before it was really ready.

"I felt then, and still feel now, that the airplane flew before it should have," says renowned test pilot Joe Cotton, a B-58 pilot for 10 years and the first to fly the XB-70 Valkyrie in 1962. "When you look at all the flight control problems, the fuel system, the landing gear and tire problems, everything we were up against—well, I always wondered if the Hustler had first flown in 1958 [instead of in 1956], we would probably have a few more fine people alive today. But I guess they could not wait when we were fighting a cold war. We were trying to push our enemy up to

COURTESY HOWARD BIALAS

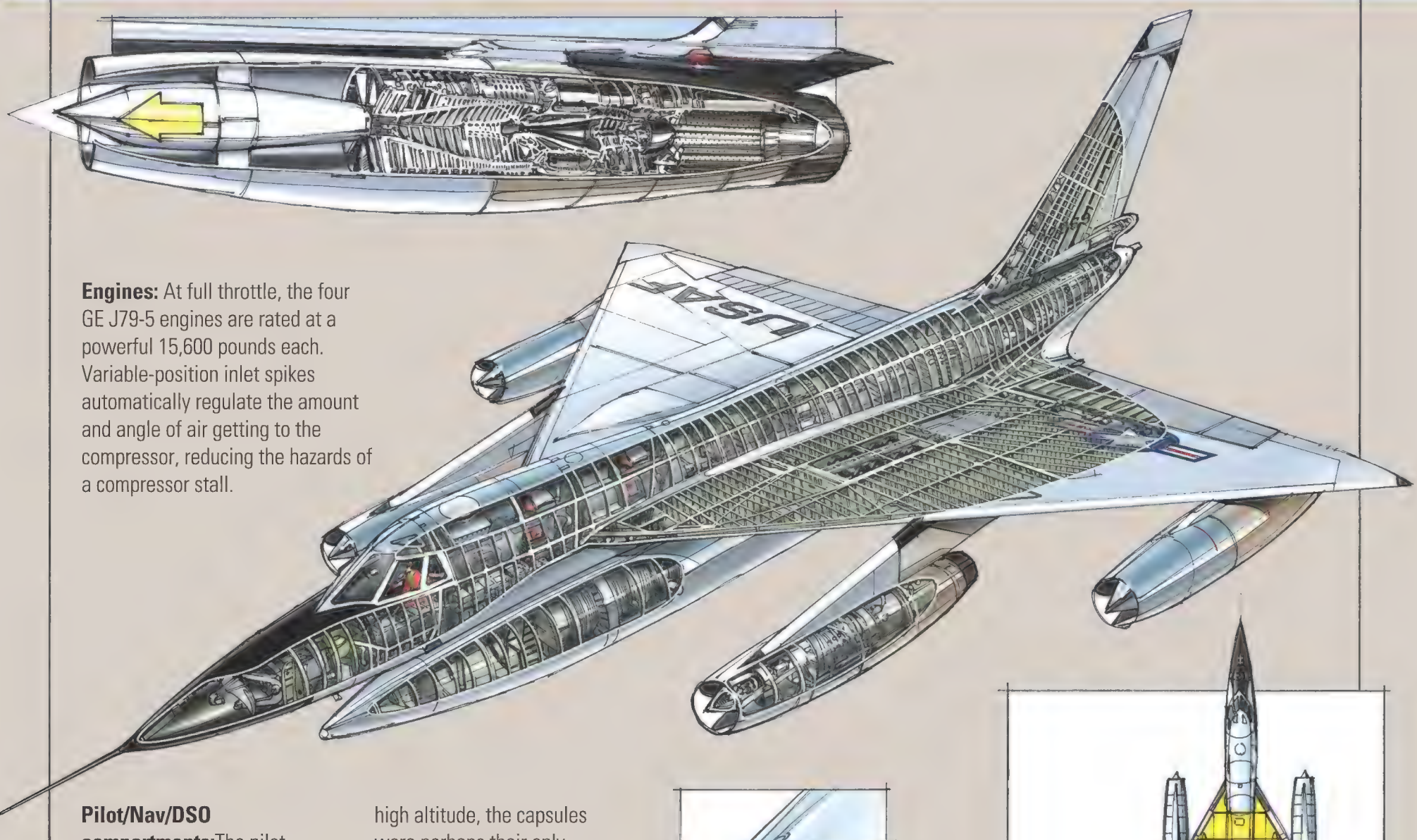
higher Mach numbers and push their development efforts to their limits. We were the aggressor and were pushing technology forward."

The B-58's complex flight control system was a cause for continual anguish; designers, pilots, and mechanics all struggled with it. Because of the delta wing configuration, the bomber had no horizontal elevators or wing-mounted ailerons. Instead, it had a very complex system of linkages that connected the wing's elevons (a combination of ailerons and elevators) to the large rudder.

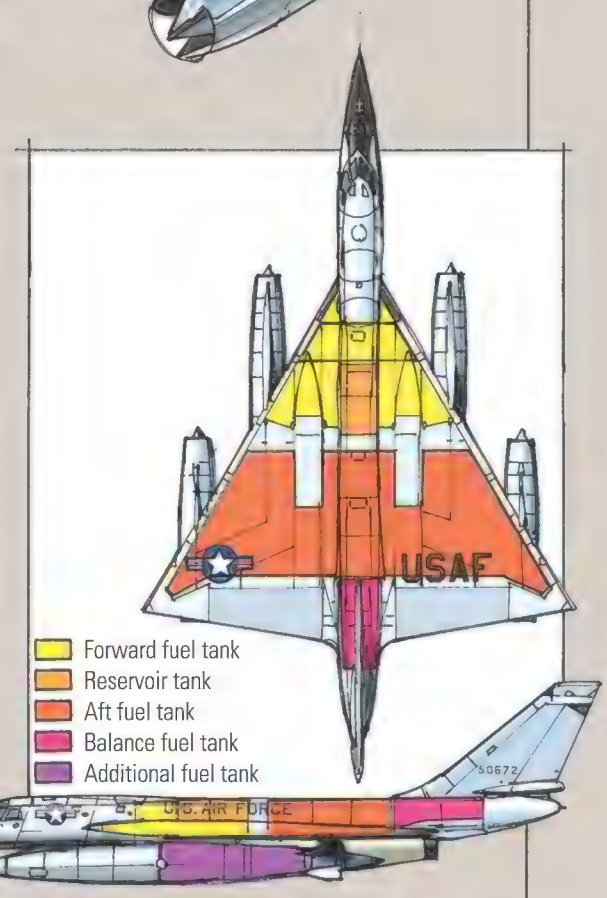
"You would sit there on the end of the runway doing all kinds of checks on the flight controls," Cotton says. "It was

B-58 Hustler

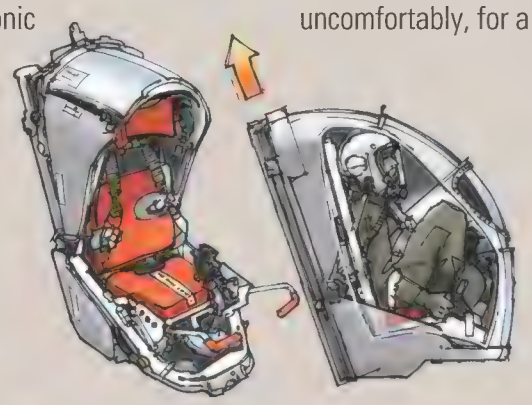
The B-58 was more than the sum of its parts. A complicated and frequently cranky fuel system and flight controls that demanded the dexterity of a surgeon were challenges the highly experienced crews dealt with daily.

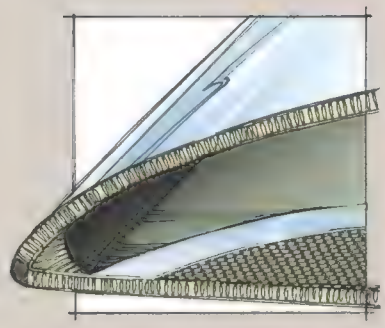


Engines: At full throttle, the four GE J79-5 engines are rated at a powerful 15,600 pounds each. Variable-position inlet spikes automatically regulate the amount and angle of air getting to the compressor, reducing the hazards of a compressor stall.

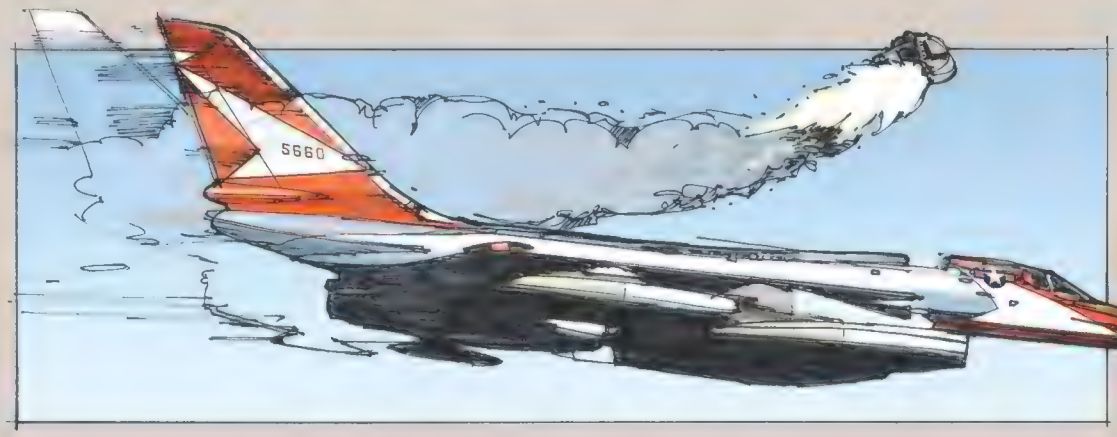


Pilot/Nav/DSO compartments: The pilot, navigator, and DSO flew isolated in their own compartments, each equipped with its own canopy, ejection seat, and escape module. Should the crew have to eject at supersonic speed and high altitude, the capsules were perhaps their only chance for survival. The pods were self-sustaining survival units, buoyant in case of water landings, and equipped with everything necessary for a downed pilot to live, albeit uncomfortably, for a week.





Structure: Convair came up with a new material called a bonded sandwich panel, comprising an aluminum alloy filled with honeycomb-structured resin. The resulting structure was incredibly strong and impossible to deform.



Fuel System: The Hustler was practically a flying fuel tank. When fully topped off it could carry over 101,000 pounds of fuel—more than 57 percent of the Hustler's gross weight. Transferring fuel among tanks at supersonic speeds caused its own share of problems. Neither the center of lift nor the center of gravity is stationary on a supersonic aircraft. The center of lift is a function of speed—as the airplane transitions from transonic to supersonic speed, the CL shifts aft. Likewise, as the aircraft slows down, the CL moves forward. CG shifts occur as an airplane consumes fuel, or when it drops its payload. The game for B-58 DSOs was to closely monitor both the CL and CG in order to maintain the stability of the aircraft in flight.

ILLUSTRATION BY HARRY WHITVER

"WE WERE TRYING TO PUSH OUR ENEMY UP TO HIGHER MACH NUMBERS AND PUSH THEIR DEVELOPMENT EFFORTS TO THEIR LIMITS. WE WERE THE AGGRESSOR AND WERE PUSHING TECHNOLOGY FORWARD."

COURTESY HOWARD BIALAS

The 1961 Thompson Trophy-winning crew reached a blistering 1,284 mph. Left to right: Howard Bialas, Harold Confer, and Richard Weir.

an extremely complex arrangement, centered around the power control linkage assembly. When I preflighted the airplane, I made sure the crew chief had it opened up so I could look up in there to see if there were any hydraulic leaks and that the rods were all connected—the system was a hydro-mechanical-electrical maze." Most pilots and crew members referred to it as the "three-bicycle wreck" since it looked like the engineers had run three bikes together.

"I think the flight control system led to the loss of a few people and aircraft," Cotton says. "It took a tremendous amount of understanding. A lot of pilots would tell you that they flew the airplane a long time before they understood what they were doing when they mixed the stick around."

Cotton also remembers the time one of his test pilots requested dismissal from the B-58 program. "He came to me and said, 'Joe, I quit.' I told him I didn't hear what he said and wanted him to think about it for two or three days—we had been investigating another B-58 crash. Anyway, he came back and said that he had really made up his mind. 'I've reached a point in my career,' he told me, 'where I can no longer control my destiny with my right hand.' [That was

NASM (SI NEG. #92-6571)

Fuel-thirsty and power-hungry, the Hustler guzzled 80,000 pounds of fuel at 800 gallons per minute from tankers like this Boeing KC-135A Stratotanker.

certainly a] real condemnation against the Hustler's flight control system."

Even in its operational life, the Hustler maintained its reputation as a dangerous airplane to fly. Darrell Schmidt, a B-58 pilot from 1966 to 1970, says, "There were 116 aircraft built, 26 of which were destroyed in accidents, with 36 crew members killed. If that doesn't fit the definition of 'dangerous,' I don't know what would."

B.J. Brown, who flew as a B-58 navigator/bombardier in the early 1960s, feels differently. "I don't have a clue as to where the B-58 got that reputation [for being dangerous]," he says. "There were a lot of men killed in the B-47...a lot of men. And I don't know that [the B-47] had a 'dangerous' stigma attached to it."

"A racehorse is dangerous if it isn't treated with tender loving care, and the same was true of the Hustler," says Howard Bialas. "It was a demanding bird, requiring constant attention, but it rewarded you with experiences unknown to mere mortals. Moving through the heavens at 20 miles per minute is an awesome experience."

The airplane's accident rate may reflect the fact that there was no two-seat trainer for the early pilots. Confer remembers early checkout rides as being not much more than an over-the-shoulder briefing.

"[Early in] the program there were no dual-control B-58s," wrote Confer in *Daedalus Flyer*, a military pilot association magazine. "After extensive ground school at the Convair plant, the first flight was a solo. At the aircraft, a test pilot would give the new pilot a briefing on the 10 'killer' items in the cockpit—as in 'Always do this; never do that; and don't ever touch that switch—good luck!' "

For the most part, pilots came away from the Hustler feeling it was a machine that demanded respect and attention. "You just had to think ahead of the airplane all the time—that was the secret to it," explains Norton. "Transition was tough because the B-58 climbed at 458 knots indicated—faster than the B-52 flew. So it took some getting used to. Those first couple of takeoffs were really exciting.

"I'd say the toughest part was landing.... You came in at

12 degrees nose up, so you really couldn't see the runway too far ahead of you.... With a normal radar approach your touchdown point was 1,500 feet down the runway. Well, in the B-58, at the high nose-up angle, it wanted to coast down the runway, so our theoretical touchdown point was actually 2,000 feet short of the runway."

The first dual-seat trainer version, the TB-58A, was delivered to the Air Force in 1960. The TB-58 and the B-58 had identical flight characteristics, including Mach 2 capability. Once the trainers entered service, the number of accidents in operational B-58s decreased dramatically. But pi-

NASM 1A23644

A Consolidated B-36 transports an XB-58 under its belly on a trip to Wright-Patterson AFB, Ohio, in 1957. Below, the encapsulated crew compartments were definitely not suited to claustrophobes.

Trophy. Howard Bialas and his crew were the only bomber crew ever to receive the Thompson Trophy.

Even with its exceptional performance, the B-58 was deployed in only two operational units. One was at Carswell Air Force Base, which was later incorporated into Little Rock Air Force Base in Arkansas, and the other was Indiana's Bunker Hill Air Force Base (later called Grissom Air Force Base).

With so few aircraft in the fleet and a rather colorful safety record, you'd think that the B-58 was unpopular with SAC flight crews. But that wasn't the case. "Crews wanted to get in it real bad," says Ben Baddley. "It was an airplane careers were made from. Not many people can say they went twice the speed of sound."

Unfortunately, while the B-58 could outrun all of its competition, the world of technology caught up with it. "Speed has a value completely by itself," says Hallion. "It reduces engagement times and windows of opportunity the enemy has to react to you. Eventually it got to a point where that, in and of itself, wasn't enough."

The development of sophisticated surface-to-air missiles (one of which famously brought down Gary

"A RACEHORSE IS DANGEROUS IF IT ISN'T TREATED WITH TENDER LOVING CARE, AND THE SAME WAS TRUE OF THE HUSTLER. IT WAS A DEMANDING BIRD, REQUIRING CONSTANT ATTENTION, BUT IT REWARDED YOU WITH EXPERIENCES UNKNOWN TO MERE MORTALS."

lots weren't the only crewmen challenged by the aircraft.

The B-58's fuel system was highly complicated, and required eagle-eye monitoring and control. At Mach 2, the B-58's center of lift naturally shifted aft, and the shift required a comparable center of gravity shift, which was achieved by transferring fuel to the balance tanks. Ideally, the defensive systems operator relied on his fuel-flow instrument and CG indicator—when everything was working correctly, that is. "Consider what could happen when one or more (and on rare occasions, all) fuel gauges failed," says Phil Rowe, a defensive systems operator from 1960 to 1965. "How would you know where the fuel was and how much there was? The answers lay in the records and logs the DSO kept...[but] let's add the complication of fuel transfer valves that might or might not open or close on command. They [failed] with some regularity, just to keep us on our toes. And, oh yes, there was one more nuance to make life interesting. There was a valve between the aft main and the aft balance tank. It was normally kept closed—except when it wasn't."

When the airplane was light, and the four General Electric J79 engines were in afterburner, the B-58 could climb at an astonishing 46,000 feet per minute. All that power was put on display during the early 1960s when the B-58 fleet broke a number of speed and range records (with aerial refueling). It won the Thompson Trophy, Bendix Trophy, France's Blériot Cup, the MacKay Trophy, and the Harmon

NASM (SI NEG. #92-6568)

Powers' U-2 in 1960), high-altitude supersonic fighters, and intercontinental ballistic missiles all spelled an end to the B-58's useful life. "I believe we may have retired it prematurely," Hallion says. "That airplane had growth potential, and could have been applied to long-range strike and air defense. We took it out of service just at the point when it could have been really useful."

It wasn't only the advancement of the enemy's defenses

HISTORY OFFICE EDWARDS AFB

that led to the demise of the B-58—political infighting and continual budgetary constraints that had plagued the airplane since its inception played their parts also. It just became too expensive. Maintenance crews reported that for every hour the B-58 flew, it took 35 hours of maintenance.

The last B-58 flew in January of 1970. Ben Baddley was the navigator/bombardier on one of the flights ferrying B-58s to their final resting place in the Arizona desert.

"It was a very sad flight for me," he says. "The B-58 was a fantastic airplane that broke new ground in so many ways. It's a shame people never really appreciated it for all that it could and did do."

"Am I proud to be associated with this great aircraft?" asks Bialas. "You bet your life. Would I do it again? In a heartbeat. Was I ever scared? Always."

COURTESY JOSEPH F. COTTON

The B-58 was the only airplane fast enough to follow the XB-70 Valkyrie. Masters of Mach: Joe Cotton (at left) and "Fitz" Fulton flew the B-58 and the XB-70.

Back in the late 1960s, the B-58's opponents were quick to say that improvements in enemy missiles and fighters made any supersonic bomber useless, but the military minds of the 21st century have a different opinion of the value of an aircraft with paint-blistering speed—especially one that also has stealth technology.

Northrop Grumman, the company that built the B-2 stealth bomber, is working with the U.S. Air Force and NASA on the next-generation Global Strike Mission aircraft. "As the threat gets more sophisticated, we are looking at a combination of high speed and high altitude, combined with advanced high survivability, low-radar-observable technologies," explains Charles Boccadoro, director for future strike systems at Northrop Grumman. "With supersonic speeds we can reduce travel time between vast distances by a factor of two or three. This means you can strike more targets with fewer aircraft, while increasing the survivability rate of the crew."

What is this next-generation bomber going to look like? "It takes a lot of what we've learned from the B-2 and modifies it for high-speed operation," Boccadoro says. "At the heart of it will be a new engine design that can maintain high propulsion efficiency for long-duration missions." One preliminary design shows a slender fuselage blending into a dramatically swept delta wing—a shape that will be familiar to any B-58 fan.

EUROPEAN SOUTHERN OBSERVATORY

GEORGE & AUDREY DELANGE

RON LUSSIER

In A.D. 1054, Anasazi artists at what is now called Chaco Canyon, New Mexico, recorded on a canyon wall (above and left) the supernova that created the Crab Nebula (photo, above, left). David Aguilar imagined what the artists saw (top).

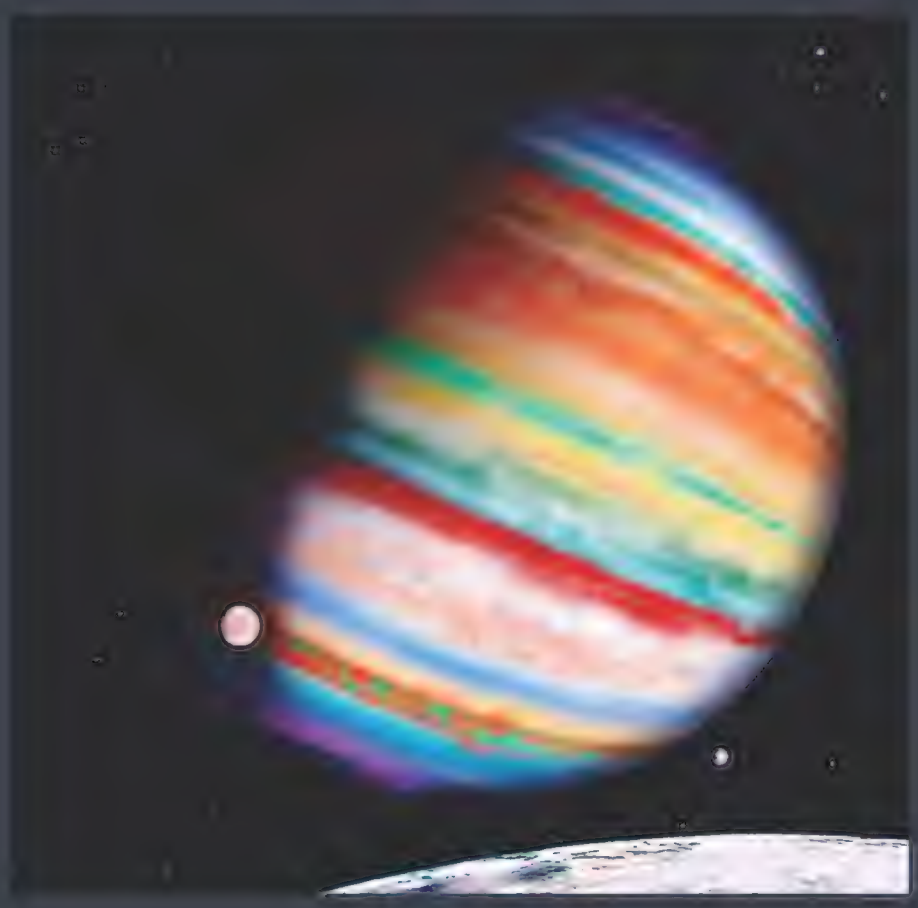
SIGHTINGS

David Aguilar sees things that other stargazers don't. An artist as well as an astronomer, Aguilar is the director of public affairs at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, where he often has to explain discoveries made using instruments "that produce data points, not photos."

Without Hubble-like pictures, Aguilar is left with his own imagination, a computer, and whatever facts researchers can glean about distant astronomical objects. "I meet with the scientist and we discuss what has been discovered: sizes, orbits, distances, chemical compositions, stellar details," says Aguilar. "Then, like a CSI investigator, I begin assembling the data to fit the observed event."

Using Photoshop software, he generates the image in layers so he can easily make changes based on updates of scientific information. One of his favorite images is of a giant "roaster" planet (below left), so named because it orbits close enough to be cooked by its parent star, with vivid colors reflecting the variety of chemicals in the planet's atmosphere. Another Aguilar vision, drawn from imagination rather than discovery: a view, perhaps in another galaxy, of a ringed planet from its watery moon (below right). For another work, Aquilar transports the viewer not far into space but far back in time—to the year 1054, when the supernova that created the Crab Nebula outshone the moon in Earth's sky (opposite, far left).

An exhibition of Aguilar's art will be on display until October 2006 at Macalester College in St. Paul, Minnesota.



Natural Sculptures

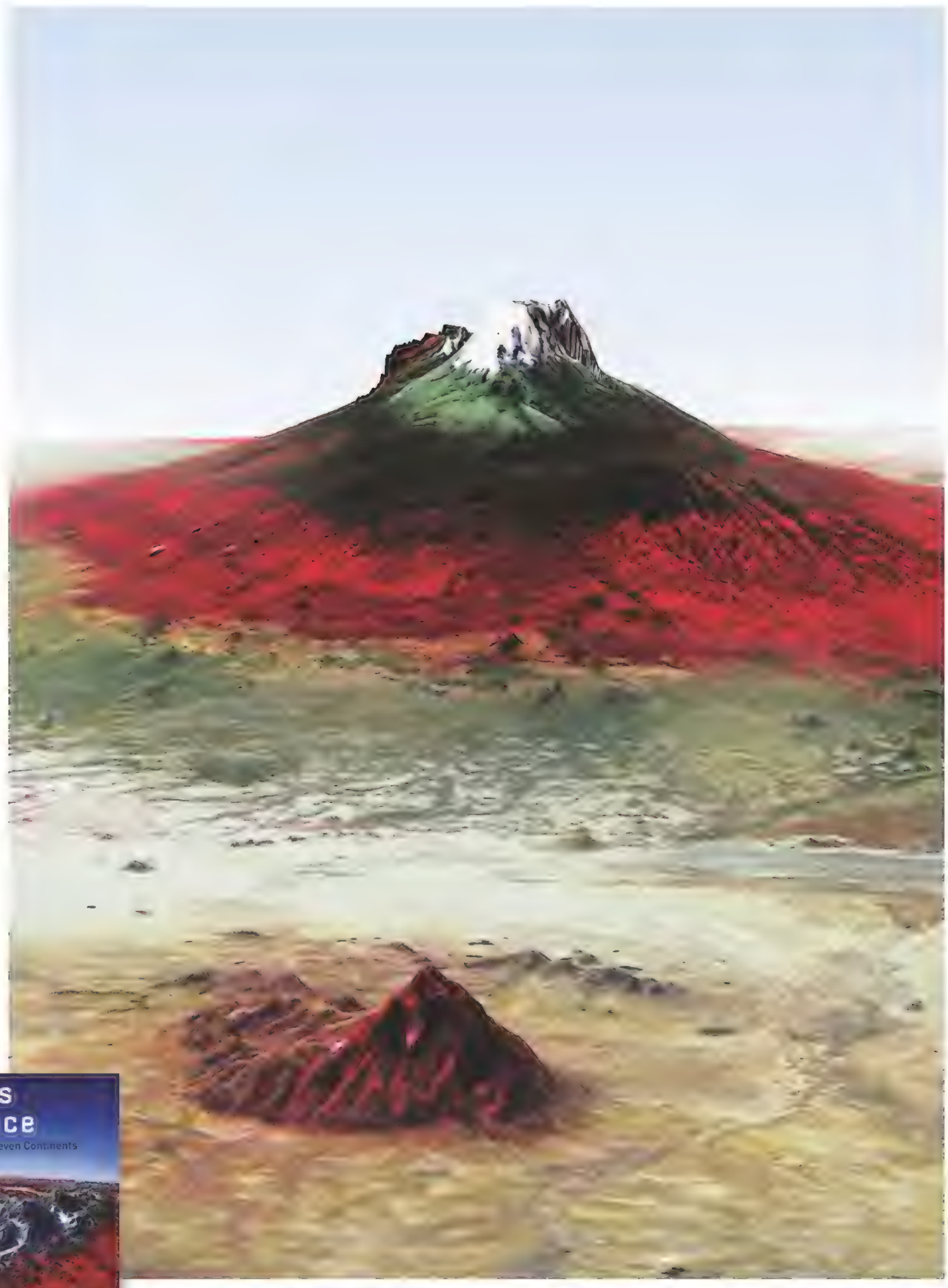
Mountains from Space

by Stefan Dech, Reinhold Messner, et al. Abrams, 2005. 243 pp., $50.00.

"It is not the mountain but the view from the peak itself that suggests an increased awareness," writes renowned mountaineer Reinhold Messner. The first man to climb all 14 of the world's 8,000-meter-plus peaks and the first to climb Mt. Everest without supplemental oxygen, Messner has the benefit of a unique perspective from which to observe that "the view that extends out from a great height is a gift."

Stefan Dech, head of the German Remote Sensing Data Center, arrives at a similarly transcendent conclusion by entirely different means: looking down at those same mountains from far greater heights.

After collecting photographs taken by astronauts and processing geophysical data from satellite instruments into photographic images, Dech cites the principle "Distance creates clarity" and "allows us to see Earth's beauty and vulnerability and appreciate its wholeness without boundaries."



COURTESY GERMAN AEROSPACE CENTER

Ice-free in 2030? Mt. Kilimanjaro, in Tanzania, rises 19,340 feet. In the past century, 80 percent of its glacier mass has melted away.

Mountains From Space is a study in contrast and complement, presenting 120 brilliantly colored images of Earth's most spectacular natural sculptures, alongside the reflections of Messner's terrestrial climbing colleagues, Rüdiger Glaser's essays on geologic history, and a selection of writings about the mystique of mountains.

In Dech's hands the collection of highly technical scientific images—including composites created by digital cameras, radiometers, spectrometers, radar systems, digital elevation models, and complex new image-rendering techniques—is curated as high art.

All of the big guns are prominently featured—the European Alps, Russia's Mount Elbrus, Tanzania's Kilimanjaro, Mt. Everest and the Himalayas, K2, Mount Fuji, Antarctica's Vinson Massif, the North American Rockies, Alaska's Mount McKinley, the South American Andes range, and Argentina's Aconcagua—as is a grand collection of the planet's volcanoes, craters, and glaciers.

Perhaps the finest sample of the advanced new imaging techniques is a

view of the Hawaiian islands revealing the islands' 18,000 feet of below-sea-level substructure. Measured from sea floor to peak—31,824 feet—Hawaii's Mauna Kea turns out to be the world's tallest mountain.

Other standout images include Uluru (the Australian mountain, also known as Ayer's Rock, that is central to aborigine dreamtime creation stories), Indonesia's Pungak Jaya, the Malaspina Glacier in Alaska, vast panoramas taken by astronauts from the International Space Station, and even one stunning satellite picture of the space station itself, majestically passing over the Himalayas.

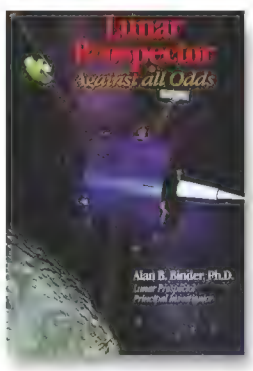
Messner, in conversation with original Everest conqueror Sir Edmund Hillary, finds himself in awe of the "ice pick with which Hillary cut the last steps on the roof ridge of the earth." Meanwhile, Rüdiger Glaser relates his hope that the latest high-tech tools for understanding mountains will be similarly inspiring—before it's too late. "The world's high mountains are ecological fever thermometers," he writes, "early warning systems for all types of environmental change, especially climate change."

The first pictures of the whole Earth as seen from space, taken during the Apollo missions, helped ignite worldwide environmental protection movements. The editors of *Mountains From Space* dare to wonder what we might do with these latest gifts of increased awareness.

—Colin Bane is a freelance writer and photographer in Washington, D.C.

Lunar Prospector: Against All Odds

by Alan B. Binder. Ken Press, 2005. 1,181 pp., $44.95.



There is no shortage of books about space missions, but *Lunar Prospector: Against All Odds* is unique in that it presents an account of a moon mission from conception to fruition, as told by the man who spearheaded the project and served as its principal investigator.

Author Alan Binder already had considerable experience in the space industry—including a 1976 stint as a principal investigator on the Viking Mars Lander mission—when the seed for Lunar Prospector, an unmanned lunar mapping expedition, was planted, sometime around Thanksgiving of 1988.

Originally conceived as a privately funded mission in 1995, Lunar Prospector was accepted into NASA's Discovery program—an attempt to do things "faster, better, cheaper." The craft launched in January 1998 and the mission ended a little more than a year and a half later.

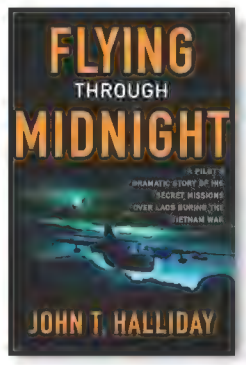
Binder has strong opinions about the U.S. space industry and doesn't pull any punches in recounting the numerous frustrations and setbacks that plagued the mission. Though the span of time covered is a little more than 13 years, sometimes it seems that he didn't omit even the most trivial detail.

In spite of this and the fact that it weighs in at nearly 1,200 pages, with additional appendices and photos archived online, *Lunar Prospector* is a surprisingly readable book. It probably could have benefited from more aggressive editing, but if you overlook the occasional dull or overly detailed bit, it is rather compelling.

—William I. Lengeman III is an Arizona-based freelance writer.

Flying Through Midnight

by John T. Halliday. Scribner, 2005. 432 pp., $27.50.



There have been a number of excellent books written about the air war in Vietnam. Unfortunately, *Flying Through Midnight* is not one of them. Retired Air Force Lieutenant Colonel John Halliday had the opportunity to tell a great story about his year flying a C-123 with the 606th Special Operations Squadron. Unfortunately, this book about them is filled with mistakes and exaggeration. The "Candlesticks," as they were known, were gutsy guys who went out night after night in slow, vulnerable, specially equipped C-123 transport airplanes to find enemy supply trucks and direct fighters in to destroy them.

Philip Caputo wrote, in the prologue to his superb Vietnam memoir, *A Rumor of War*, "The veteran's inclination [is] to remember things the way he would like them to have been rather than the way they were." Perhaps I should ascribe the flaws in Halliday's chronicle to that.

There are several glaring errors in

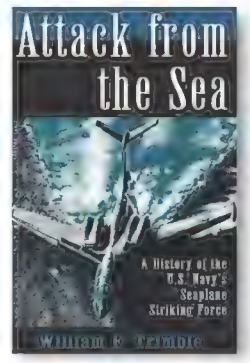
Halliday's book: He writes about being chased by a MiG-18 at night. Not only do MiGs rarely fly at night, but there weren't any MiG-18s in Vietnam. He also claims to have flown his C-123 into bad weather and hung the airplane on its props like a helicopter, at a speed of 50 knots, which any pilot will tell you is impossible. Halliday misrepresents Long Tieng airfield (where he makes a supposed nighttime emergency landing), describing it as an abandoned 2,000-foot dirt strip, with no lights or navaids. In reality, Long Tieng was a bustling airfield with a 4,670-foot paved runway with two navaids. General Vang Pao (whom Halliday refers to as General Bang Pow) made it his headquarters in 1955.

There is a slight chance that Halliday experienced all the incredible events he so glibly describes, but well before the end of his account, I quit caring.

—Lieutenant Colonel Bob Hanson, U.S. Air Force (ret.), was a career fighter pilot who flew 122 combat missions in Vietnam, many at night, and some in support of the Candlesticks.

Attack from the Sea: A History of the U.S. Navy's Seaplane Striking Force

by William F. Trimble. Naval Institute Press, 2005. 238 pp., $27.95.



In the 1950s, the United States Navy was in danger of being marginalized by the expansion of the Air Force's strategic bomber force. Eager to remain a player in the growing nuclear confrontation with the Soviet Union, the Navy envisioned stationing transports and bombers on the world's oceans, where fixed runways wouldn't be needed and mobility was assured. Sailors tested flying boats like the Martin P6M Seamaster long-range jet bomber, the Convair R3Y Tradewind turboprop tanker-transport, and the Convair F2Y Sea Dart fighter.

William Trimble, chair of the history department at Auburn University in Alabama, traces the Navy's sea-based strike force back to the 1930s, when United States strategic planners wanted to get ready for possible war with Japan by positioning warplanes in the Pacific. And then in the 1950s, with its acquisition of big aircraft carriers stymied during political fighting with the Air Force, the Navy revived the seaplane strike force idea.

By the 1960s, however, the Navy no longer needed seaplanes—they had been made technologically obsolete. The Seamaster, Tradewind, and Sea Dart—and the dreams that went with them—were retired, only to return almost a half-century later in Trimble's comprehensive history of the Navy's seaplane program.

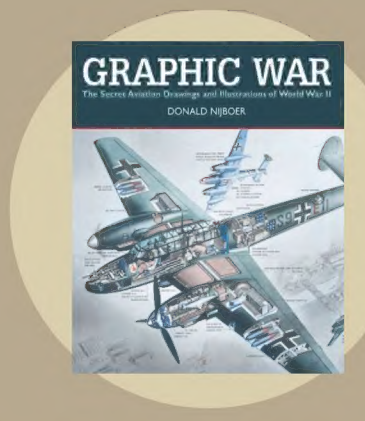
—Robert F. Dorr, an Air Force veteran and retired U.S. diplomat, is the author of Chopper, *a history of American helicopter pilots.*

SHORT AND SWEET

Spitfires and Yellow Tail Mustangs: The 52nd Fighter Group in World War Two

by Tom Ivie and Paul Ludwig. Specialty Press, 2005. 176 pp., $53.95.

A comprehensive, almost day-by-day account of airmen at war, teeming with rare archival photos and detailed after-action reports. The fighting record of the 52nd Fighter Group, which produced 21 Aces, makes it a worthy subject for a book, and constant action keeps the detailed narrative buzzing along.



Graphic War: The Secret Aviation Drawings and Illustrations of World War II

by Donald Nijboer. Boston Mills Press, 2005. 272 pp., $49.95.

During the Second World War, artists were recruited to produce highly detailed technical drawings of new aircraft. This collection of previously unpublished and "Restricted—Official Use Only" manuals and cutaway illustrations presents some of the most eye-catching from England, the United States, and Germany.

CALENDAR

December 3
U.S. Coast Guard & Marines Day. Evergreen Aviation Museum, McMinnville, OR, (503) 434-4006, *www.sprucegoose.org.*

December 10
Annual Santa Welcome. Olympic Flight Museum, Olympia, WA, (360) 705-3925, *www.olympicflightmuseum.com.*

December 12
Slipstream Session: "A Remembrance of War" Seminar Series. An in-depth look at the history of some of the airplanes of the Commemorative Air Force Ghost Squadron. American Airpower Heritage Museum, Commemorative Air Force Headquarters, Midland International Airport, TX, (432) 563-1000, ext. 2259, *www.airpowermuseum.org.*

Organizations wishing to have events published in Calendar should fax press releases two months in advance to (202) 275-1886; e-mail them to editors@si.edu; or mail them to Calendar, Air & Space/ Smithsonian, *MRC 951, P.O. Box 37012, Washington, DC 20013-7012.*

Statement of ownership, management and circulation (required by 39 U.S.C. 3685) of *Air&Space/Smithsonian* published bimonthly by Smithsonian Business Ventures, MRC 951, P.O. Box 37012, Washington, D.C., 20013 for October 1, 2005. General business offices of the publisher are located at 750 Ninth Street, N.W., Suite 7100, Washington, D.C. 20001. Name and address of publisher is Thomas Ott, MRC 951, P.O. Box 37012, Washington, D.C., 20013 . Name and address of editor is George Larson, MRC 951, P.O. Box 37012, Washington, D.C., 20013. Owner is Smithsonian Institution, 1000 Jefferson Drive, Washington, D.C. 20560. Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities: None. The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes have not changed during preceding 12 months (Section 411.3, DMM). The average number of copies of each issue during the preceding 12 months are: a) Total number of copies printed: **271,259**; b) Paid and/or Requested Circulation: (1) Sales through dealers and carriers, street vendors, and counter sales (not mailed) stated on Form 3541: **17,471**; (2)Paid or Requested Mail Subscriptions (include Advertisers' proof copies/Exchange copies) stated on Form 3541: **227,229**; c) Total paid and/or requested circulation: **244,700**; d) Free Distribution by Mail (Samples, Complimentary, and Other Free): **2,903**; e) Free Distribution Outside the Mail (Carriers or Other Means): **5,785**; f) Total Free Distribution: **8,688**; g) Total Distribution: **253,388**; h) Copies not Distributed: (1) Office use, Leftovers, Spoiled stated on form 3541: **(13,005)**; (2) Return from News Agents: **30,876** ; i) Total: **271,259**; j) Percent Paid and/or Requested Circulation: **97%**. The actual number of copies of single issue published nearest to filing date are: a) Total number of copies printed: **264,198**; b) Paid and/or Requested Circulation: (1) Sales through Dealers and Carriers, Street Vendors, and Counter Sales (Not Mailed) stated on Form 3541: **7,550**; (2) Paid or Requested Mail subscriptions (include Advertisers' proof copies/ Exchange copies)stated on Form 3541: **222,541**; c) Total Paid and/or Requested Circulation: **230,091**; d) Free Distribution by Mail (samples, Complimentary, and Other Free): **2,095**; e) Free Distribution Outside the Mail(carriers or other means): **5,484**; f) Total Free Distribution: **7,956**; g) Total Distribution: **238,047**; h) Copies not distributed: (1) Office use, Leftovers, Spoiled stated on form 3541: **11,441;** (2) Return from News Agents: **14,710**; i) Total : **264,198**; j) Percent Paid and/or Requested Circulation: **97%**. I certify that all information furnished is true and complete.

(Signed) Thomas Ott
President & Publisher, Smithsonian Magazine Group

CREDITS

"Something Was Very Wrong." Freelancer Scheherazade C. Fowler lives in Portland, Maine, and coaches sailing at Bowdoin College.

Cotton Candy, Hot Dogs, and Parachutes. Mechanical engineer Nick D'Alto credits boyhood memories of Coney Island's Parachute Tower as an inspiration to pursue a career in designing aerospace structures.

Rotary Club. Carl Hoffman has flown on helicopters in New Orleans, Los Angeles, Houston, Alaska, Greenland, and New Guinea. He once attended a week of helicopter flight school, where he managed to hold a hover. For about five seconds.

"If it moves, shoot it!" has been Tyson V. Rininger's motto since he peered through a camera at age 15. Unable to become a naval aviator, he resorted to aviation photography, a career that puts him in the air with some of the world's best pilots.

Watch This Space. Geoffrey Little wrote "Spaceman," about the long career of astronaut John Young, for the Aug./Sept. 2005 issue of *Air & Space/Smithsonian*.

The Contenders. Photographer Cameron Davidson shoots for a mix of magazine and advertising clients. When not hanging out of a Hughes 500 or a Bell JetRanger, he is dreaming about flying.

Frozen in Time. Montana-based writer Tom Harpole is a frequent *Air & Space* contributor.

Clark James Mishler is an Alaska-based photographer whose work has appeared in such publications as *National Geographic*, *Cosmopolitan*, and the *Los Angeles Times*.

Midnight Raiders. Nicholas Nirgiotis freelances from his home in Florida. He is at work on a history of lighter-than-air aviation, from which this article is excerpted.

The Invisible Killers. John F. Ross is a writer living in Bethesda, Maryland. He is working on a book about the French and Indian War for Random House.

Speed Freak. Dale Smith is an aviation writer living in Jacksonville, Florida. He still remembers the awe he felt watching a B-58 take off from Miami International Airport in 1961.

In the Wings...

CAROLINE SHEEN

Red Bull's Douglas DC-6B almost fits in its maintenance hangar.

Hangar of the Rich and Bullish

What's a classy pavilion with a five-star restaurant, two bars, and a view of the Austrian Alps doing with a B-25J Mitchell bomber and a dozen other vintage aircraft?

Going Ballistic

If you have a spare 200 grand, a half-dozen new companies want to sell you a seat for a 120-mile trip—up and down.

Empire Express

For Navy PV-1 Ventura crews based on the Aleutian island of Attu, World War II was a series of nine-hour missions to attack Japan from the north, with a prayer each time for enough fuel to make it back.

...and All Points in Between

A historical ramble through non-directional beacons, radio ranges, and other navaids, all made obsolete by the Global Positioning System.

Level 3: Low Earth Orbit, Ladies' Shoes

One day a ribbon of carbon nanotube composite will stretch 62,000 miles up from Earth—a space elevator climbable by cargo trains to orbit. Last October, it was 164 feet of ribbon suspended from a crane in California. It's a start.

www.airspacemag.com

The Convair B-58 may have had maintenance problems, a high accident rate, and skittish pilots, but the Hustler itself remains a thing of beauty (see "Speed Freak," p. 64). For those who can't get enough, a host of images of the dazzling yet doomed airplane are posted online. And don't miss the image showing to what heights photographer Chad Slattery will ascend to get a cover shot for the magazine. On the Web, you can also order a subscription or send us a letter.

Ridin' High

Carol Rymer Davis has been flying balloons for over 30 years. But it would be hard to top the last year as far as her accomplishments in aviation.

Davis, a 62-year-old from Denver, recently won three prestigious awards for her sport—the international Sabiha Gokcen Medal and the Harmon Aeronaut Trophy, the United States' oldest award for ballooning. The Sabiha Gokcen Medal, given by the Fédération Aéronautique Internationale, is awarded to a woman whose flight is considered the most outstanding achievement in any air sport. (Gokcen, the medal's namesake, was Turkey's first female combat pilot.) Davis and her teammate, Richard Abruzzo, shared the Harmon trophy for the most outstanding international achievement in ballooning.

Davis also won the Katherine and Marjorie Stinson Award for Achievement from the National Aeronautic Association. The award is given annually to a woman for an outstanding and enduring contribution in aviation or a meritorious flight.

How did Davis end up becoming one of the most decorated balloonists in history in a single year? Decades dedicated to ballooning was a good start, but winning the Coupe Aéronautique Gordon Bennett in 2004 didn't hurt either.

The Gordon Bennett, first run in 1906, is the world's oldest balloon race. Although women have participated in the race before, none had ever been a member of the winning team. Davis and Abruzzo won the distance race by travelling 1,120 miles.

"It's huge to be the first woman [to win]," says Davis. "It's satisfying because I have been doing this for so long. To finally be recognized as having really achieved something, it's an honor and makes me feel good about my career."

Davis began flying balloons in 1973. By 1975 she was competing in balloon races, taking 10th place that year in the U.S. National Championships.

Davis made her first mark in the record books in 1978, taking a hot-air balloon to 25,000 feet (a record for balloons with envelopes of 900 to 1,200 cubic meters). She broke her own record the next year, going to 31,300 feet, a mark that still stands. Winning the Gordon Bennett last year, however, was her crowning achievement.

COURTESY RICHARD ABRUZZO

Davis' teammate, Richard Abruzzo, at takeoff from Thionville, France, in 2004.

The premise of the Gordon Bennett is simple enough: Fly as far in a gas balloon as you can. But it takes a great deal of skill to keep a balloon afloat over long distances, since it has no means of locomotion and depends on the winds and air currents to carry it. Davis and Abruzzo have been flying together since 1996, and qualified for the Gordon Bennett by winning the 2003 America's Challenge Gas Balloon Race.

Despite encountering a downpour in last year's race that soaked most of the equipment and supplies in their gondola—a basket only three and a half by four feet—the team finally touched down in Vannas, Sweden, after 52 hours and 52 minutes aloft.

In this year's Gordon Bennett, held in October in Albuquerque, Davis and Abruzzo were forced to land early when their balloon struck a power line. Abruzzo fell from the gondola upon impact, and Davis quickly landed the balloon.

"Richard and I really want to win [the Gordon Bennett] three times," Davis says, undeterred. "That would be quite an accomplishment."

—Dustin Gouker

LOGBOOK

The Wright Brothers Trophy

Edward C. "Pete" Aldridge, Jr., has been selected to receive the 2005 Wright Brothers Memorial Trophy, presented annually by the National Aeronautic Association. The trophy, which was first presented in 1948, is awarded "for significant public service of enduring value to aviation in the United States." Previous recipients of the Wright Brothers Trophy include Charles Lindbergh, Jimmy Doolittle, Kelly Johnson, Herb Kelleher, Neil Armstrong, and John Glenn.

Aldridge is a 43-year veteran of the aerospace industry. He served for more than 18 years in the U.S. Department of Defense, most recently as Under Secretary for Acquisition, Technology, and Logistics. He was also Under Secretary and then Secretary of the Air Force under President Ronald Reagan. After retiring from the defense department, Aldridge was appointed by President George W. Bush to chair the president's "Moon to Mars" commission.

In the 1980s, Aldridge was an astronaut in training for the first planned mission to launch from Vandenberg Air Force Base, California. That mission was canceled after the *Challenger* accident.

Aldridge has received a number of awards from numerous societies, including the Rotary National Award for Space Achievement in 1994, and the Bob Hope Distinguished Citizen Award from the National Defense Industrial Association in 1998. He also served as president of the Institute of Aeronautics and Astronautics from 1997 to 1998.

The trophy will be presented during the Wright Memorial Dinner, hosted by the Aero Club of Washington on December 16 at the Washington, D.C. Hilton hotel.

Moments & Milestones is produced in association with the National Aeronautic Association. Visit the NAA Web site at www.naa-usa.org *or call (703) 527-0226.*